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ABSTRACT

This unit of instruction on integrated pest management was designed for use by agribusiness and natural resources teachers in Florida high schools and by agricultural extension agents as they work with adults and students. It is one of a series of 11 instructional units (see note) written to help teachers and agents to educate their students and clients about the problems of energy shortages and strategies for energy conservation and management. This unit has been subdivided into seven subunits, each containing one to several modules. Topics covered in this unit include principles of integrated pest management; insect identification; scouting; monitoring and forecasting insect pests; preventive pest control practices; biological pest control; chemical controls; practical applications of the course content for insect, nematode, disease, and weed control; and energy saving concepts of pest control. The unit contains student performance objectives, content information, teaching-learning activities, student handouts, transparency masters, and evaluation instruments. (KC)

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LOW ENERGY TECHNOLOGY
A UNIT OF INSTRUCTION
IN
FLORIDA AGRICULTURE
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

Developed by

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1981

This public document was promulgated at a cost of \$2164.58 or \$2.88 per copy to inform teachers and students in agriculture/agribusiness of the latest low energy technology in crop protection with integrated pest management.

This unit of instruction was developed as a part of the Low Energy Technology Program of the Institute of Food and Agricultural Sciences, University of Florida. Additional copies of this and other units of instruction in Low Energy Technology can be obtained by contacting the Instructional Materials Service, 101 Rolfs Hall, University of Florida, Gainesville, Florida 32611.

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INTRODUCTION

Integrated Pest Management (IPM) is a relatively new approach to an old problem: how to insure crop protection and maintain yield and quality through controlling pest populations, while minimizing effects on people and the environment. IPM is a system that makes use of a combination of various pest control methods to keep pests from doing serious damage.

By making use of a balanced approach IPM can reduce the amount of pesticides needed. The energy used for chemical pest protection can be saved and farmers can save both energy and money. Saving energy this way can also reduce the harmful effects of increased chemical applications to the environment.

This unit of instruction has been subdivided into seven units. Each unit contains student performance objectives, content and teaching-learning activities. After the completion of these units, the students will be able to:

Unit 1 - Concepts and Principles - Page 6

Module: Introduction - Page 6

1. Name five kinds of pests and give an example of each.
2. Write, in 50 words or less, a definition of Integrated Pest Management.
3. List the six steps involved in a successful low energy IPM program.

Unit 2 - Identification - Page 17

Module: Insect Identification - Page 17

1. Write, in 100 words or less, why proper insect identification is important in energy conservation.
2. Select three pests out of a list of ten major insect pests on Florida field crops and vegetables and describe in writing:
 - stages of each insect's life cycle when it damages the crop.
 - crop plants affected by each insect.
 - part of plant on which each insect feeds.

Unit 3 - Scouting, Monitoring and Forecasting - Page 28

Module: Introduction - Page 28

1. List two ways that scouting or monitoring pests can save energy in agriculture.
2. List three reasons for scouting or monitoring crop pests.
3. Define the terms, economic threshold and economic injury level.
4. Name one other benefit that can be gained from scouting.

Module: Insect Pests - Page 32

1. Write, in 100 words or less, the steps involved in scouting a field for insect pests.
2. List three factors to consider before applying pesticides for damage done by insects.
3. Scout a field for insect pests.

Module: Nematodes - Page 37

1. Identify three symptoms of nematode damage.
2. Sample a field for nematodes, handle and package the sample according to state nematology lab specifications, given equipment (soil probe, bucket, plastic bags).

Module: Plant Diseases - Page 42

1. List three conditions that must be monitored in order to forecast plant diseases.
2. Write two ways that energy can be saved by monitoring or forecasting.

Unit 4 - Preventative Pest Control Practices - Page 47

Module: Resistant Varieties - Page 47

1. Describe, in writing, how farmers can save energy by planting resistant or tolerant varieties.

Module: Cultural Practices - Page 51

1. List five cultural practices that can help save energy in a farm pest management system. Write one paragraph about each and explain how it conserves energy.

Module: Regulatory Pest Control - Page 55

1. List four regulatory control measures which help save energy.

Unit 5 - Natural Controls - Page 58

Module: Biological Pest Control - Page 58

1. List the three classes of organisms used in biological control of pests.
2. Write, in 50 words or less, how natural or biological control organisms can help conserve energy.
3. Write, in 100 words or less, how pesticides interfere with natural controls and two ways to prevent this.

Unit 6 - Chemical Controls - Page 63

Module: Reading the Label - Page 63

1. Given examples of pesticide labels, write the type of pesticide, formulation, storage and disposal precautions, toxicity category, amount of active ingredient, application restrictions, and crops and pests it can be used on.

Module: Pesticides and Energy - Page 78

1. List three ways that pesticides contribute directly or indirectly to overall energy use.

Module: Pesticide Application - Page 80

1. List four precautions that can be taken to assure the effectiveness of chemical pesticides with as little waste as possible.
2. List three different types of spray nozzles and describe the spray pattern from each nozzle.
3. List and define six major parts of a sprayer.

Module: Calibrating the Sprayer - Page 91

1. Briefly explain why it is important to properly calibrate a sprayer.
2. Complete sample problems on pesticide applications, given information on spraying equipment and pesticide requirements.
3. Demonstrate ability to use the Nomograph.
4. Given a common pesticide and a low pressure spray rig, calibrate the sprayer and mix the material so that it can be applied according to the label recommendations.

Unit 7 - Practical Applications - Page 108

Module: Insect Control - Page 108

1. List three methods of controlling insect pests and write one way that each uses or saves energy.

Module: Nematode Control in Peanuts-Soybeans - Page 111

1. List five methods of control that can be used together or separately to control nematodes in peanuts and/or soybeans.
2. Write a description, in 200 words or less, of each of three control methods that can be integrated for nematode control in soybeans and will save energy by reducing the amount of chemical treatment needed.

Module: Disease Control - Page 117

1. List three methods for control of crop diseases and write one way that each uses or saves energy.

Module: Weed Control - Page 119

1. List and explain two ways that weeds compete with crops for energy.
2. List and explain five ways commonly being used to control weeds.
3. List and explain three ways to save energy in weed control.

Module: Unit Summary - Page 123

1. Given a list of types of crops and livestock, write one class of pest affecting each and two control methods that can be used to save energy in the management of that pest.

This unit of instruction includes student performance objectives, content information, teaching-learning activities, student handouts, transparency masters and evaluation instruments. Use a copy machine to reproduce the student handouts and make the transparencies.

This unit of instruction was designed for use by Agribusiness and Natural Resource teachers in Florida high schools and by extension agricultural agents as they work with youth and adults. This unit of instruction was developed by the Department of Agricultural and Extension Education, Institute of Food and Agricultural Sciences as part of the Low Energy Technology Program.

The writers would like to acknowledge the following members of the University of Florida whose expert advice contributed greatly to the production of this unit.

Dr. William J. Becker	Agricultural and Extension Education
Dr. John R. Strayer	Entomology
Dr. Freddie A. Johnson	Entomology
Dr. Robert A. Dunn	Nematology
Dr. James L. App	Extension Administration

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: CONCEPTS AND PRINCIPLES

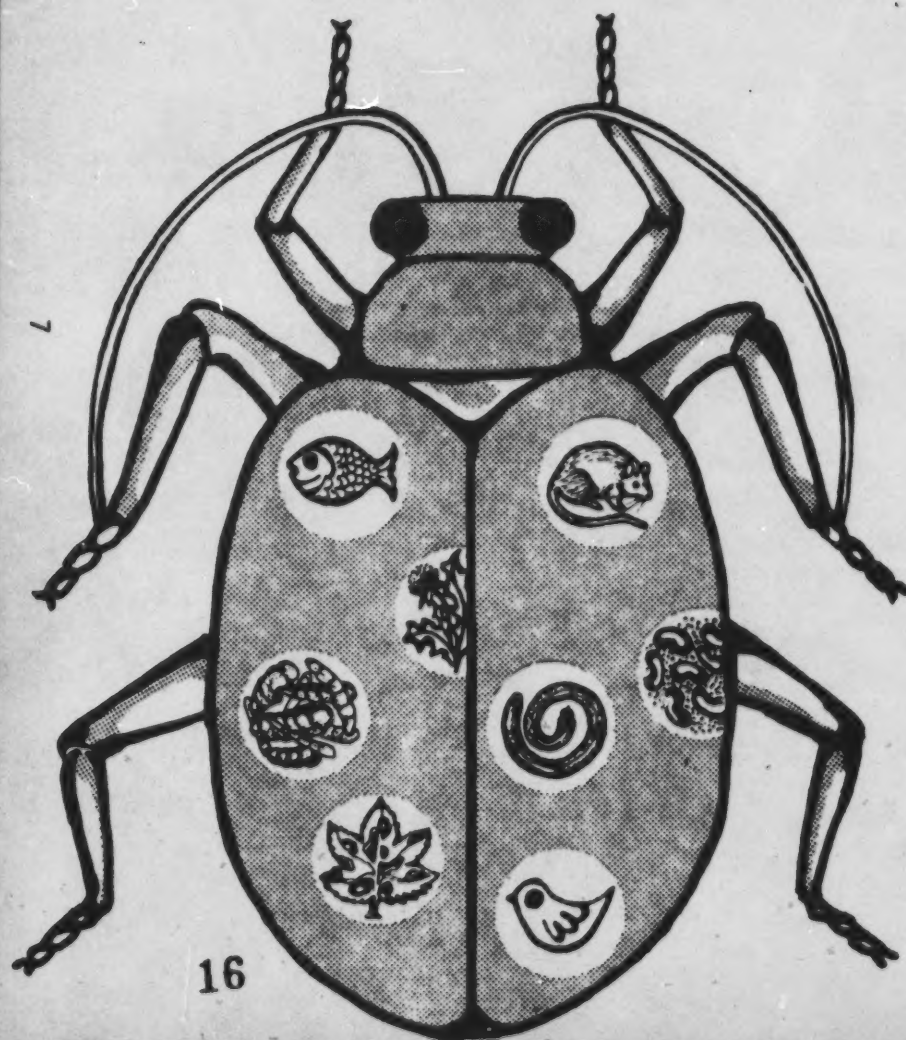
MODULE: INTRODUCTION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. Name five kinds of pests and give an example of each. 2. Write in 50 words or less, a definition of Integrated Pest Management. 3. List the six steps involved in a successful low energy IPM program.	A pest is any organism that is harmful to humans, animals or crops. Pests can be: - insects - weeds - diseases - mites - nematodes - mice - others Integrated Pest Management is a system that makes use of a combination of various pest control methods to keep pests from doing serious damage. This system can save both money and energy and reduce harmful effects on the environment. <u>IPM Program</u> - identification of pest and beneficial organisms - preventative cultural practices - monitor pest populations (scouting) - prediction of loss and risk - decision or action to be taken - evaluation and follow up	Read handout: <u>Pests</u>. Read handout: <u>Integrated Pest Management: The Concept and Principles</u>. Show slide/cassette set, "IPM" available from IFAS editorial. Discuss transparency <u>Steps for Energy Savings in Pest Management</u>. Read handout: <u>Survey Sheet</u>, Each student will interview parents or local farmer to get information on pest control methods being used and complete survey sheet. Results will be compiled and reported to the class for discussion. Have students complete <u>Evaluation</u>.

HANDOUT

PESTS

Cooperative Extension Service
Center for Environmental Programs
Institute of Food and Agricultural Sciences
University of Florida, Gainesville



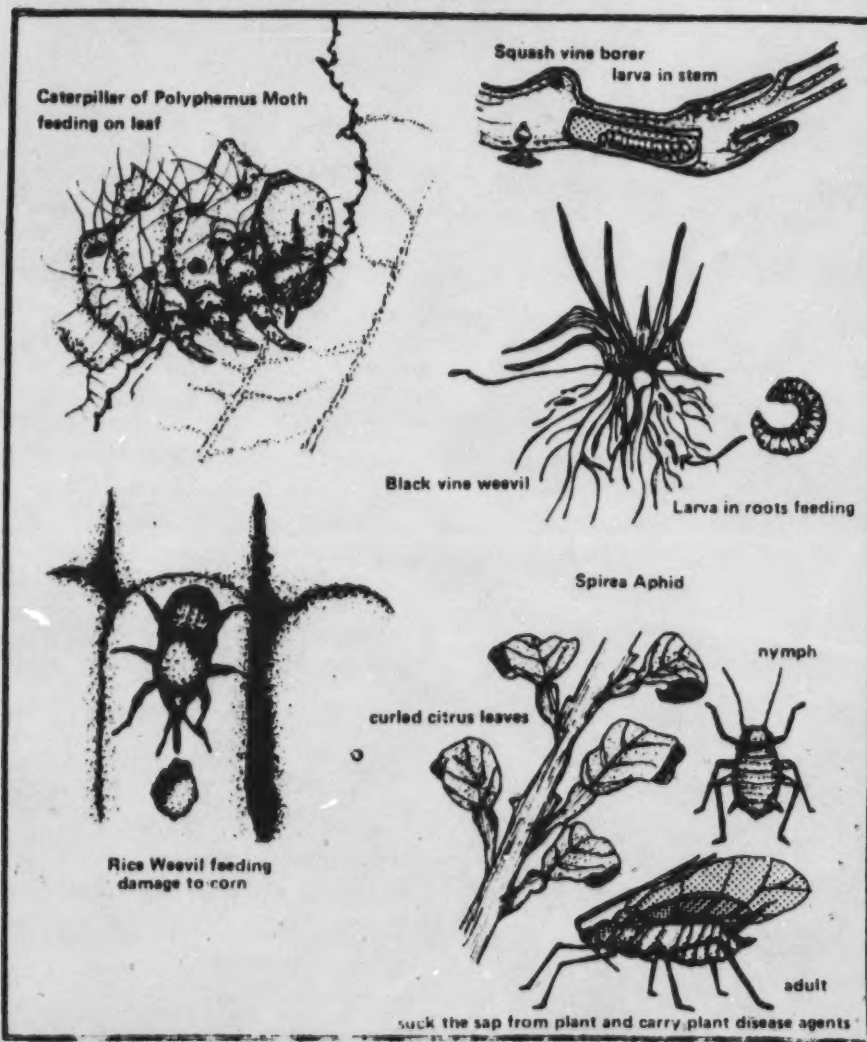
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INSECTS

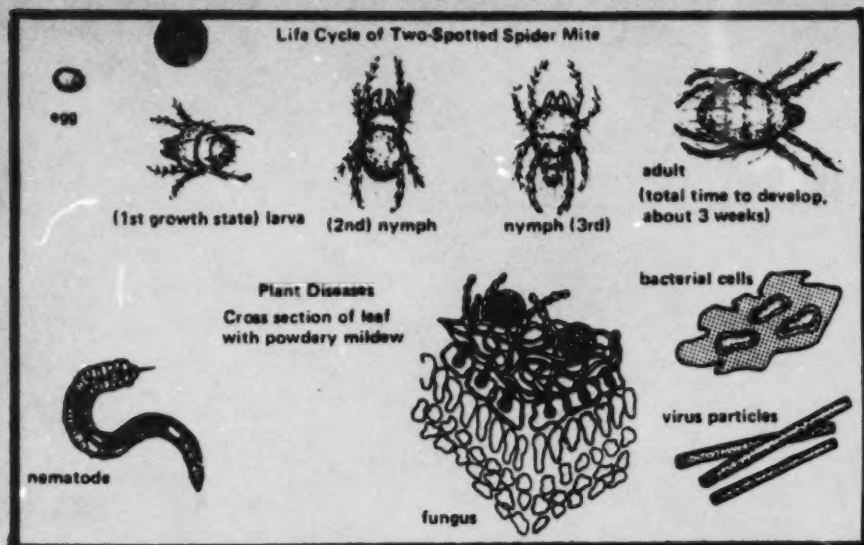
Many types of insects affect crops. They cause damage in a variety of ways. They may:

- feed on leaves,
- tunnel or bore in stems, stalks, and branches,
- feed on and tunnel in roots,
- feed on and in seeds and nuts,
- suck the sap from leaves, stems, roots, fruits, and flowers, and
- carry plant disease agents.

The plants are damaged, weakened, or killed. This causes reduced yields, lowered quality, and ugly plants or plant products that cannot be sold. Even after harvest, insects continue their damage in the stored or processed products. Insects also feed on and in man and other animals.



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MITES, TICKS, AND SPIDERS

Mites, ticks, and spiders are closely related to insects. The main differences are that the adults have eight jointed legs instead of six and have two body regions. They do not have wings.

PLANT PARASITIC NEMATODES

Nematodes are small, unsegmented roundworms. Different kinds live in the oceans, in fresh water, as parasites of animals and man, in the soil, and as parasites of plants. The plant parasitic nematodes comprise a very small fraction of all the kinds of nematodes known to exist. However, every kind of plant has some kinds of nematodes which can live on it and may damage it in some way. The mild climate, the sandy soils, and the great variety of plants grown combine to give Florida more kinds and more severe problems with plant nematodes than almost anywhere else.

How Does Nematode Feeding Affect Plants?

- Nematodes cause lesions, discoloration, deformity, and in some cases, complete devastation in the penetration and feeding areas.
- Plants under attack by nematodes lose vigor and become unthrifty.
- The size and quality of fruits and vegetables are reduced.
- Nematodes cause decline, and in extreme cases, death of the plant.
- The puncture wound left by the stylet opens the door for fungal or bacterial invasion, which may do more damage than the nematode.

PLANT DISEASES

What is a plant disease? A plant is diseased when its chemistry, structure or reproductive ability is abnormal.

What causes plant diseases? Plant diseases can be caused by either non-living or living agents. The most common living agents causing plant diseases are:

- fungi,
- bacteria,
- viruses.

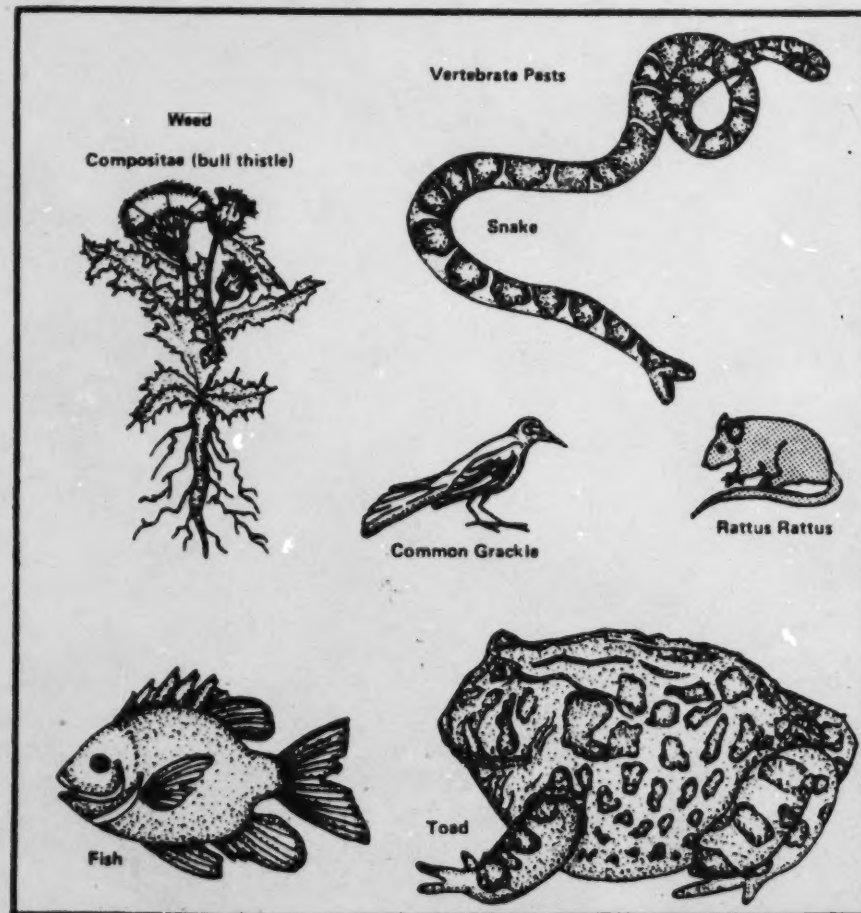
WEEDS

A weed is simply "a plant out of place." Weeds are a problem because:

- they reduce crop yields,
- they make land use less efficient,
- they reduce product quality,
- some cause skin irritation in man, and others are poisonous to man and animals, and
- they spoil the beauty of turf and landscape plants.

RECOGNIZING COMMON FEATURES OF VERTEBRATES

All vertebrate animals have a jointed backbone. They include fish, snakes, turtles, alligators, lizards, frogs, toads, salamanders, birds, and mammals.



This public document was promulgated at an annual cost of \$459.15, or 2.3¢ per copy to inform Florida producers of proper pesticide use.

HANDOUT

INTEGRATED PEST MANAGEMENT: THE CONCEPT AND PRINCIPLE

Integrated Pest Management (IPM) is a relatively new approach to an old problem: How to insure crop protection and maintain yield and quality through controlling pest populations while minimizing effects on people and the environment. IPM attempts to make the most efficient use of the strategies available to control pest populations by taking action to prevent problems, suppress damage levels and use chemical pesticides only where needed. Rather than seeking to eradicate all pests entirely, IPM strives to prevent their development or to suppress their population numbers below levels which would be economically damaging.

Integrated means that a broad, interdisciplinary approach is taken using scientific principles of crop protection in order to fuse into a single system, a variety of methods and tactics.

Pests include insects, mites, nematodes, plant pathogens, weeds, and vertebrates which adversely affect crop quality and yield.

Management refers to the attempt to control pest populations in a planned, systematic way by keeping their numbers or damage within acceptable levels.

The goals of an IPM program are:

(1) Improved Control. IPM will provide more effective pest control to maintain and sometimes improve quality and yield. For example, by implementing alternatives to strict dependence on pesticides, IPM makes use of a balanced approach, relying for example, on cultural practices, natural enemies (parasites or pathogens) and host plant resistance as well as chemicals. By reducing the use of pesticides, IPM will be able to emphasize biological control and the conservation of natural enemies already occurring in the field. IPM may provide new weapons for the producer's arsenal against pests.

(2) Pesticide Management. IPM will supply a more efficient and sensible approach to pesticides, thus increasing their effectiveness and useful life span and decreasing possible adverse effects.

(3) Economical Crop Protection. IPM will control pest populations more economically. For example, simply by treating crops as needed, instead of merely by the calendar, IPM can often reduce protection costs by reducing the amount of pesticide used and the number of applications.

(4) Reduction of Potential Hazards. IPM will better safeguard peoples' health and the environment from possible harmful side effects associated with pesticides.

These are the steps towards a successful, low energy pest management plan.

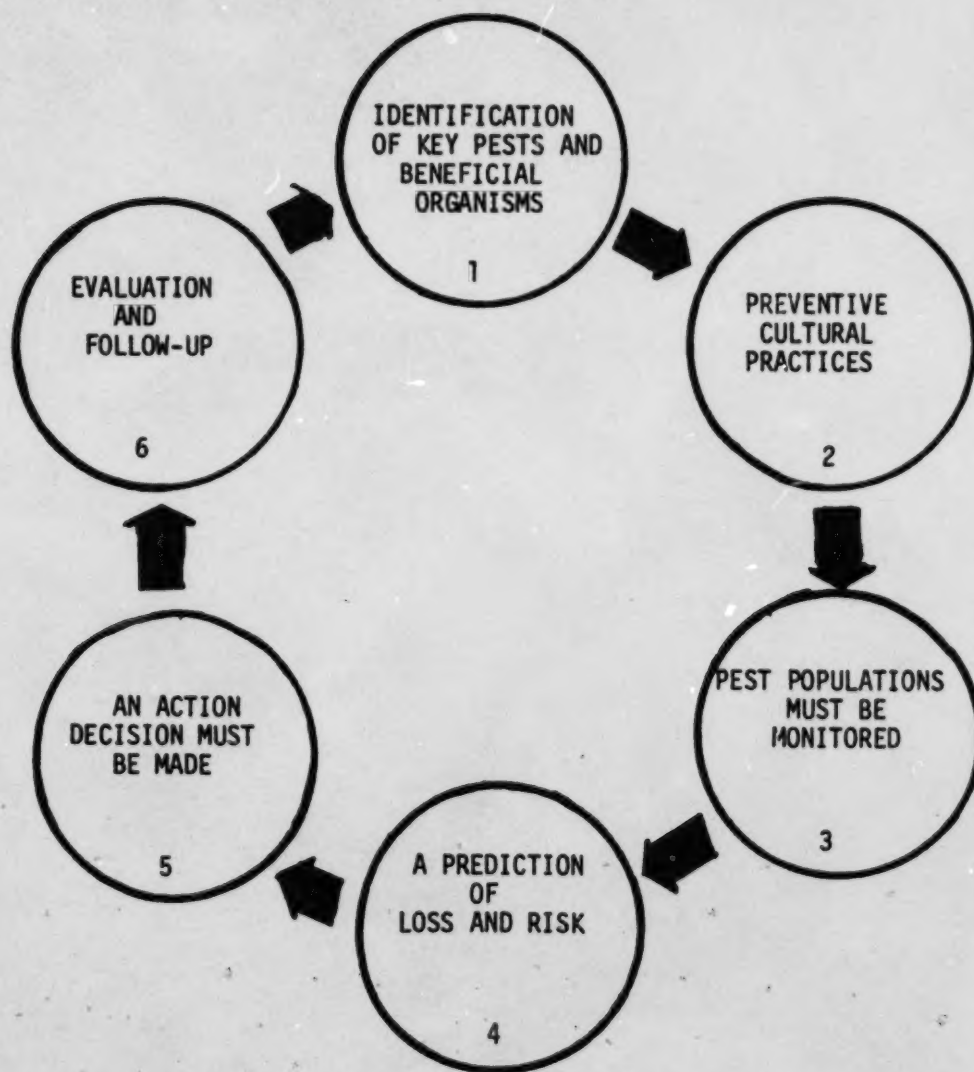
- (1) The identification of key pests and beneficial organisms is a necessary first step. In addition, biological, physical and environmental factors which affect these organisms must be considered.
- (2) Preventative cultural practices are selected to minimize pest population development. These practices include soil preparation procedures, use of resistant plants, specified planting dates, etc.
- (3) Pest populations must be monitored by training "scouts" who routinely sample fields and fill out a scouting report with information on pest population densities.
- (4) A prediction of loss and risks involved is made by setting an economic threshold. Pests are controlled only when the pest population threatens acceptable levels of quality and yield: Remedial action is taken. The level at which the pest population or its damage endangers quality and yield is often called the economic threshold. The economic threshold is set by predicting potential loss and risks at a given population density. This estimation takes into account weather data, state of crop development, markets, risk benefit, costs and kinds of control available.
- (5) An action decision must be made. In some cases, pesticide application will be necessary to reduce the crop threat, while in other cases, a decision will be made to wait and rely on closer monitoring.
- (6) Evaluation and follow-up must occur throughout all stages in order to make corrections, assess levels of success and to project future possibilities for improvement.

WHO BENEFITS FROM IPM?

- Producers benefit from decreased production costs and by having a more balanced and effective means to control pests, and by reduced risks to crop yield and people's health.
- Farm workers benefit by reduced exposure to pesticides and avoid risks upon re-entry to work areas.
- Chemical companies benefit by having a longer, useful life for their pesticides, insofar as they may avoid a build-up of resistance to their chemicals.

- Consumers' health benefits by enjoying food with minimal or no pesticide residue.
- Fish and wildlife benefit by less exposure to pesticides in their food chain.
- The water, the air and the soil system will remain less contaminated from misuse of pesticides.
- Society as a whole will ultimately reap benefits from maintained levels of production, energy savings, better quality food and an environment less contaminated by potentially dangerous chemicals.

STEPS FOR ENERGY SAVINGS
IN PEST MANAGEMENT



HANDOUT

SURVEY SHEET
PEST CONTROL METHODS ON THE FARM

Crops grown

- 1)
- 2)
- 3)

Cultural practices used for pest control

- 1)
- 2)
- 3)

Resistant crop varieties

- 1)
- 2)
- 3)

Do you hire scouts?

How often are fields scouted?

Chemical pesticides used

- 1)
- 2)
- 3)
- 4)

Pests treated with pesticides

Insects

1)

2)

3)

Weeds

1)

2)

3)

Diseases

1)

2)

3)

Nematodes

Approximately how much is spent on pesticides each year?

Do you use any biological control methods?

1)

2)

Livestock pests - do you use

dustbags?

eartag?

spray?

EVALUATION

1. Name five kinds of pests and give an example of each

Pest

Example

2. Write, in 50 words or less, a definition of Integrated Pest Management.

3. List the six steps involved in a successful, low energy IPM Program.

Step 1.

Step 2.

Step 3.

Step 4.

Step 5.

Step 6.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: IDENTIFICATION

MODULE: INSECT IDENTIFICATION

STUDENT PERFORMANCE OBJECTIVES

CONTENT

TEACHING-LEARNING ACTIVITIES

The student will be able to:

1. Write, in 100 words or less, why proper insect identification is important in energy conservation.

Importance of insect identification

- use proper chemical for control of specific insect
- possibility of controlling insect with other methods
- depending on life cycle, stage of plant growth, treatment may not be needed
- early control of dangerous pest, before damage is done
- protection of beneficials

Read handout: Insect I.D. for Energy Savings.

Discuss: Other benefits of proper insect identification.

Read handout: Florida Insect Pests.

Activity: As a class project, students will collect and identify insects from crop plants in the area. These will be mounted or preserved in the classroom and could be classified according to affected plants, life cycle stage, parts of the plant they damage, etc.

2. Select three pests out of a list of ten major insect pests on Florida field crops and vegetables and describe in writing:

- stages of each insect's life cycle when it damages the crop
- crop plants affected by each insect
- part of plant on which each insect feeds

Major crop pests on Florida field crops and vegetables, and how to identify them.

- life cycle stages
- crops damaged
- parts of plants damaged

Read handouts: Insects Life Cycles,
Insects Attacking Florida Field Crops and Vegetables.

Discuss transparencies: Three Stage Life Cycle, Four Stage Life Cycle.

Discuss: Why are so many caterpillars major crop pests?

Have Students complete Evaluation.

HANDOUT

INSECT I.D. FOR ENERGY SAVINGS

Before it is possible to make any pest management decisions, it is important to correctly identify the pest.

Insect pests can usually be identified quite easily in the field. Proper identification does, however, require some practice since insects will be found at different stages of their life cycle.

By knowing exactly what insects are present in a field the grower has taken the first step towards saving energy in a pest management program.

A properly identified insect is more easily killed. If a grower decides that insecticides are needed, he will get best results when the chemical used is intended for the pests he wants to control. Successful control with the first spraying means energy savings.

Often, when an insect is identified, the grower will find that some alternate control tactic can be used. Some insect pests can be controlled biologically or by using some cultural method. These are usually low energy methods.

After identifying a pest, a grower may decide that control measures are not needed at that time. Depending on the stage of the insect's life cycle and the growth stage of the plant, it may be determined that the insect won't do enough damage to make control necessary.

Sometimes, a potentially destructive pest can be found early, before it is a problem. By treating it right away, a grower can save on large amounts of pesticides (and energy) that would be needed to control the insects later when the population grows.

Many insects are not pests at all. Some are very helpful in killing pest insects. By properly identifying these beneficials, a grower may be able to save energy by utilizing them for biological control of pests.

HANDOUT

FLORIDA INSECT PESTS

There are several insect pests which can cause a reduction in yield or quality of crops in Florida. Some of these pests feed on seedlings, some on foliage and others on pods or fruit. Research has shown that crop plants can often tolerate considerable loss of foliage without suffering economic yield loss. Because of the type of damage that each insect pest does and the different control measures necessary for each pest, it is necessary to identify the insects correctly. The following list contains information on the more common insect pests of Florida field crops and vegetables.

Velvetbean caterpillar - This is generally the most damaging foliage feeder of soybeans in Florida. The worms have four pairs of abdominal prolegs. Caterpillar coloration is most commonly green although dark brown and black forms can also be found late in the season. There are usually distinct yellow and white stripes running the length of the body and the head capsule is yellow colored.

These worms are very active and will drop from the soybean plants and wiggle actively when disturbed. Worms less than $\frac{1}{2}$ inch long "loop" when they crawl and are often misidentified as soybean loopers. Caterpillars less than $\frac{1}{2}$ inch long eat a total of only $\frac{1}{3}$ of a leaflet. However, worms larger than $\frac{1}{2}$ inch long eat approximately $3\frac{1}{2}$ average-sized soybean leaflets.

Caterpillars require about 6 days to develop though the first three stages (up to $\frac{1}{2}$ inch long). The fourth, fifth and sixth stages take about 8 days to develop and the entire life cycle (egg, larva, pupa and adult) takes 30-35 days.

The most important periods to watch for velvetbean caterpillar damage are August and September. This is the time when major damage to soybeans by this pest occurs and when control measures may be justified.

The velvetbean caterpillar is not thought to be able to survive the winter in north Florida. It spends the winter in extreme south Florida and further southward on the Caribbean Islands and in Central and South America. Each summer the moths fly or are carried by the wind to the Florida panhandle.

Stink bugs - These are several different species of stink bugs that can cause damage to soybeans in Florida. The southern green stink bug is usually more common than the brown stink bug.

The barrel-shaped eggs of these are laid in clusters of 10 to 50 on the underside of soybean leaves. The eggs hatch into nymphs which feed in clusters until they are about $\frac{1}{2}$ of an inch long. The nymphs vary in color but normally have distinct bright-colored markings. The nymphs and adults have piercing-sucking mouthparts and damage the soybeans by sucking the juices from the immature seeds. This may cause quality loss, yield loss and reduce seed viability. The time from egg hatch to adult is about 35 days.

Adult stink bugs spend the winter in leaf litter, under bark and other similar protected places in north Florida. In the spring they fly to wild host plants such as wild dogwood, elder, peppervine, sumac, wild grape and black locust where they undergo their first generation.

Normally the adults move to soybeans in August and can damage the crop up to harvest. Sometime high stink bug populations are found in the border rows next to their wild hosts. When this is the case, spot treatment is advised. Because of the "spottiness" of the stink bug in soybeans, thorough sampling is especially important.

Corn Earworm or Cotton Bullworm - The corn earworm has many hosts including corn, cotton, soybeans, tobacco and tomato as well as peanuts. Corn earworms vary in color from light green to nearly black. It has four pairs of abdominal prolegs and can easily be identified from the other worms on peanuts by the spines and dark spots on their body and their yellow to orange head. They are normally lighter in color on their undersides and have light stripes running the length of their bodies.

When disturbed, they will drop to the ground and curl up into a tight C-shape. The corn earworm will feed for approximately 14 days and may reach 1½ inches in length when fully grown.

Loopers - Loopers cause occasional problems on many crops in north Florida. They are usually pale green with white stripes running the length of their bodies. They can easily be separated from the other worms that feed on field crops by their two pairs of abdominal prolegs. All of the other worms found on Florida crops have more than two pairs of abdominal prolegs.

Fall armyworms - Several species of armyworms can cause damage to almost any crop in Florida. The fall armyworm is one of the more common armyworms found on field crops. The female moth lays its eggs in a fuzzy cluster on foliage usually on the bottom side of the leaves.

The worms have four pairs of abdominal prolegs and coloration and stripes that are variable. Usually they are greyish with lighter stripes running the length of their body. Their head is usually dark with a light-colored inverted "Y" mark on the front. The fall armyworm feeds for approximately 14 to 21 days and the entire life cycle takes 30-35 days.

The fall armyworm cannot survive the winter in north Florida. The moth flies or is carried by the wind northward each year and is usually more of a problem from early to mid-season on peanuts, corn and soybeans.

Spider mites - Spider mites are tiny pests 1/60 of an inch long that are closely related to insects which feed by sucking fluid from the leaves. They generally feed on the lower leaf surface. At high population levels, the leaves may turn a dusty-looking yellow color and die.

Aphids - Aphids are soft-bodied insects about 1/16 of an inch long which feed by sucking plant juices from the plant leaves. They can either be winged or wingless and vary in color from pale green or dark green to almost black. Aphids are common in many Florida crops and large populations can cause considerable damage by reducing plant vigor through their feeding on plant juices.

Southern corn rootworm - Larvae of the southern corn rootworm damage corn, soybeans and peanuts by feeding on the roots, pegs or pods in the soil. Southern corn rootworm damage can be difficult to detect. Damage is variable; it can range from a decrease in grade to a complete destruction of the crop.

The southern corn rootworm tends to be more of a problem in damp weather and on heavier type soils. However, under wet conditions, it can also damage crops on sandy soils.

Adults of the southern corn rootworm are called cucumber beetles and are greenish-yellow in color, about 1/4 to 3/8 inch long with 12 irregular dark or black spots on their back. Generally, the adults are not a pest of field crops, but vegetables.

The major damage to field crops is done by the cream-colored larva which is about 1/2 inch long when fully grown. The larva appear to be two-headed since both ends have a brown spot resembling the head.

Whitefringed beetle - Whitefringed beetle adults are dark gray in color and about 1/2 inch in length with a white fringe or band along each side of the body. The adults feed on the outer margins of plant leaflets.

However, the major damage done to field crops is by the larva of the whitefringed beetle. The larva can cause sporadic but serious problems on crops in Florida. The larva which are yellowish-white, legless, up to 1/2 inch long and rather stout with many circular ridges surrounding their body, feed on the roots and other underground parts of the plant.

Lesser cornstalk borer - This caterpillar is small (up to 5/8 inch long) with alternating aqua-blue and purplish-brown bands on each segment. It lives in a silken tube that is attached to the plant just beneath the soil surface. It bores into the plant and tunnels up the stem causing damage. When not feeding, the lesser cornstalk borer stays in the silken tube. When disturbed the worm will wiggle rapidly. It can be a problem in dry weather and is more common on sandy soils.

Plants suffering from lesser cornstalk borer damage often appear wilted. Those plants that survive may be weakened and lodge later in the season. The lesser cornstalk borer is most damaging on seedling soybeans, corn and peanuts and on plants up to 12 inches tall.

Vegetable leafminer - The leafminer is one of the most serious insect pests on Florida vegetables. Tomatoes, celery, and beans are a few of the crops that can be seriously damaged by leafminers.

The leafminer is the tiny caterpillar larva of a small moth. The moth lays its eggs in a leaf. When the eggs hatch, the worm eats its way around between the surfaces of the leaf. The trails or "mines" left by leafminers are easily seen.

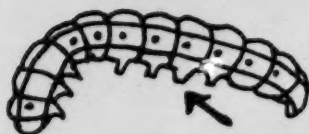
Boll weevil - Adult weevils are brown with a long snout. These can damage the foliage of cotton and some other crops. The worst damage from boll weevils comes from adults laying eggs inside the cotton boll (fruit). The eggs hatch out and the larva feed inside the boll, reducing cotton yields. Adult weevils and fully grown larva are about $\frac{1}{2}$ inch long.

All of the caterpillars found in soybeans have specific characteristics which enable identification of one from another. The illustration below shows details of the proleg characteristics used to separate caterpillars. Caution: remember small worms (less than $\frac{1}{2}$ inch long) may not show the number of abdominal prolegs as illustrated. Use of a magnifying glass or hand lens is encouraged when examining small worms.



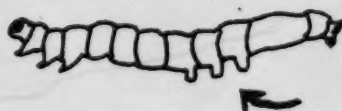
VELVETBEAN CATERPILLAR
(*Anticarsia gemmatilis*)

4 abdominal prolegs, very active when disturbed. These small caterpillars "loop" when they walk and are often mistaken for soybean loopers.



CORN EARWORM
(*Heliothis zea*)

4 abdominal prolegs, rolls up into a ball when disturbed.



GREEN CLOVERWORM
(*Plathypena scabra*)

3 abdominal prolegs drops when disturbed



SOYBEAN LOOPER
(*Pseudoplusia includens*)

2 abdominal prolegs and walks with a "looping" motion.

HANDOUT

INSECT LIFE CYCLES

Insects such as beetles and moths go through several stages before they become adults. These stages include the eggs, larvae, pupae and adults and are known as the life cycle.

Egg - Eggs are laid by the adults. They may be laid individually or in groups of 10 to 150 eggs depending on the pest. Generally, eggs are small about the size of a pinhead and depending on the pest, are laid on the leaves, stems or soil around the plants. A single larva comes from each egg.

Larva - This stage is also known as the worm or caterpillar stage in the life cycle of a moth. When the larva or worm first hatches from the egg it is quite small (about the diameter of a hair and approximately 1/8 inch long). As the larva feed, they grow larger. When full grown, the larva can be 1/2 inch in diameter and 1 1/2 to 2 inches long.

One of the characteristics that can be used in the field to determine which worm pest is present is the number of pairs of abdominal prolegs. Abdominal prolegs along with some other parts of a worm are shown in the previous handout. All true caterpillars have one pair of anal prolegs.

Of all the stages, larva do the most damage because of their feeding. When the larva are full grown, they turn into pupae.

Pupae - This stage does not do any damage. Depending on the pest, pupae can be found fastened to plant foliage or in the soil around the plant. Adults come from the pupae.

Adults - The adults have wings and are usually capable of flying. Moths do not damage plants, however, beetles such as the whitefringed beetle feed on leaves. After mating, the adults can lay eggs and begin the life cycle over again.

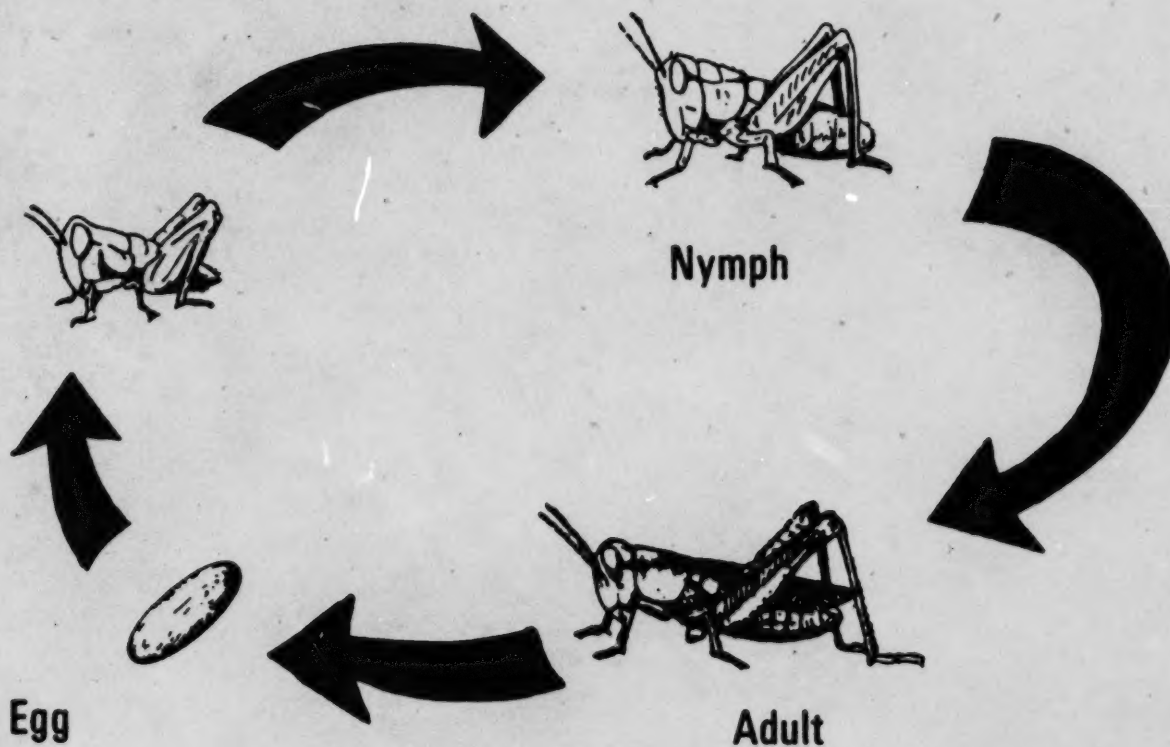
Some of the insect pests of agronomic crops have a different life cycle than that described above. The threecornered alfalfa hopper has only three stages in its life cycle: egg, nymph and adult. When nymphs hatch from the eggs, they resemble the adults except that the nymphs do not have wings. The adults and particularly the larger (older) nymphs cause the most damage.

HANDOUT

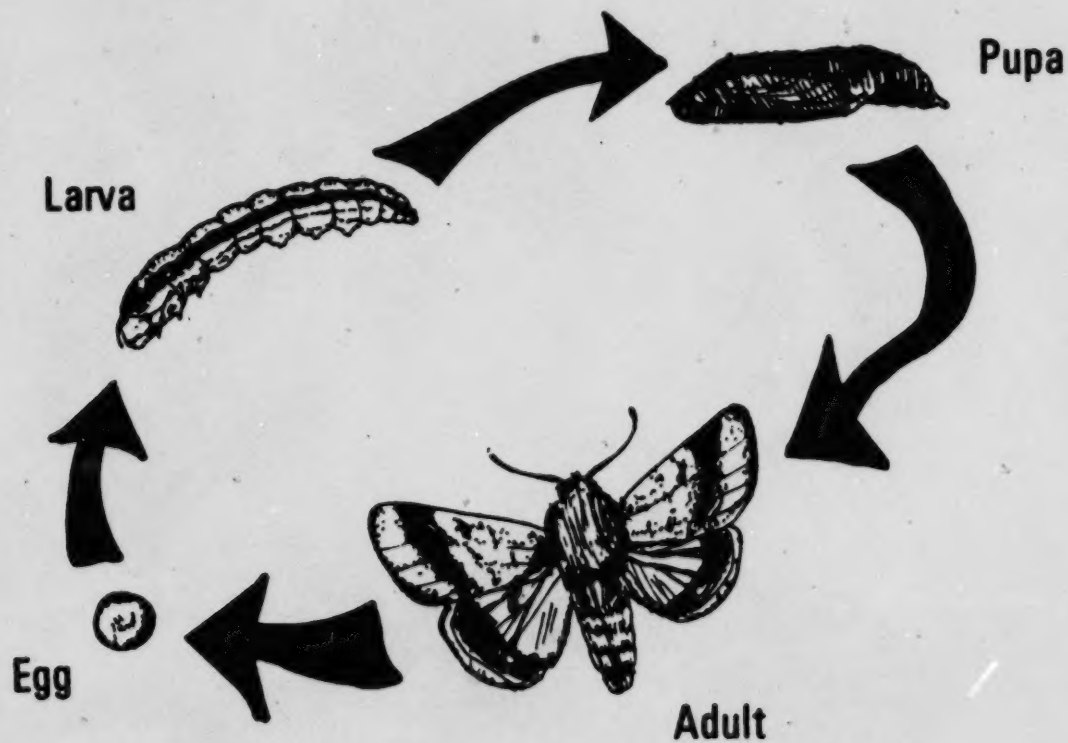
INSECTS ATTACKING
FLORIDA FIELD CROPS AND VEGETABLES

Name	Stage in Life Cycle	Plant(s) Eaten	Part of Plant Eaten
Velvetbean Caterpillar	Larvae	Soybeans, Peanuts	Foliage (leaves)
Looper	Larvae	Soybeans, Peanuts Cabbage, Vegetables	Foliage
Army Worms	Larvae	Corn, Peanuts, Soybeans, Vegetables	Foliage, pods, and seeds
Cotton Boll Worm or Corn	Larvae	Cotton, Corn, Soybeans	Pods, grain and Foliage Bolls
Lesser Cornstalk Borer	Larvae	Corn, Soybeans Peanuts	Seeds, Pods
Stink Bug	Adults and Nymphs	Soybeans, Pastures Vegetables, Citrus	Leaves, Fruit
Aphids	Adults and Nymphs	Pastures, Vegetables Citrus	Leaves, Fruit
Southern Corn Rootworm	Larvae	Corn, Peanuts	Roots, Pods, and Pegs
Vegetable Leaf Miner	Larvae	Tomatoes, Celery Beans, Vegetables	Leaves
Boll Weevil	Adult and Larvae	Cotton	Cotton Boll and Leaves
Whitefringed Beetle	Adult and Nymphs	Pastures, Soybeans Peanuts, Vegetables	Foliage, Roots

Three Stage Life Cycle



Four Stage Life Cycle



EVALUATION

1. Write in 100 words or less, why proper insect identification is important in energy conservation.

2. Choose three (3) insects from the following list and write . . .
 - a. stage of each insects' lifecycle when it is damaging to crops.
 - b. crop plants affected by each insect.
 - c. part of the plant on which each insect feeds.

Velvet bean caterpillar, looper, army worm, cotton boll, lesser cornstalk borer, stinkbug, aphid.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: SCOUTING, MONITORING AND FORECASTING

MODULE: INTRODUCTION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. List two ways that scouting or monitoring pests can save energy in agriculture.	Scouting and Monitoring - timely and efficient control measures will protect crop and the energy invested - careful monitoring may result in less chemical applications - natural control organisms can be used, reducing the need for chemicals	Read handout: <u>Scouting and Energy</u> .
2. List three reasons for scouting or monitoring crop pests.	Scouting can determine - if pest problems exist - extent of the problem - if natural controls are present - if action is needed - what kind of action to take (pesticides, cultural controls, etc.)	Read handout: <u>Why Take the Time to Scout?</u>
28		Show film, <u>Wanted, Plant Pest Detectives</u> IFAS Editorial Department.
3. Define the terms, economic threshold and economic injury level.	Measurements used in Monitoring - economic threshold - economic injury level	Read handout: <u>Measurements Used in Monitoring Pests</u> .
4. Name one other benefit that can be gained from scouting.	Additional benefits of scouting create more awareness - of field management - water conditions - fertility conditions	Have students go to the land lab and observe a section of a field crop for 10 minutes. Have them look for pests weeds, insects, diseases, etc. Discuss findings in class. Did they notice anything else, such as soil conditions, dryness, etc?

HANDOUT

SCOUTING AND ENERGY

By carefully monitoring crop pest numbers, farmers can save much of the energy usually used in their control. A farmer can decide, according to the number and kinds of pests in the field, whether or not pesticides are needed. Many growers apply pesticides on a regular scheduled basis. They don't really know if the chemicals are needed or not but will spray just to make sure that the pests don't become a problem.

Scouting or monitoring pests can result in less spray applications and less energy use. Farmers who monitor fields closely will know what pests are present, how many there are and how much damage they are doing. Knowing this, they can be sure of applying the right chemicals at the right time and in the proper amounts. Pests are most easily controlled when they are spotted early. Weeds can be killed with just a light spraying of herbicide if they are treated at the seedling stage. Herbicide and energy are saved by spraying weeds early. Insects and diseases can also be controlled best when treated early. If the populations become very large, a larger dose of chemicals, and more energy will be needed. Monitoring pest populations will usually result in less pesticide applications and less energy use. This is due mainly to the farmer knowing precisely when to spray, what to spray and how much to spray.

Natural enemies of insect pests should also be looked for by scouts. If many of these natural enemies are present, they may be able to keep pests under control. When pests are killed by natural enemies, chemical treatment is not needed. This means large savings of energy.

Monitoring pests can save energy in other ways. If large populations of certain pests are noticed late in the season, a farmer may decide on cultural controls such as sanitation or crop rotation, that will save energy the following year.

HANDOUT

WHY TAKE THE TIME TO SCOUT?

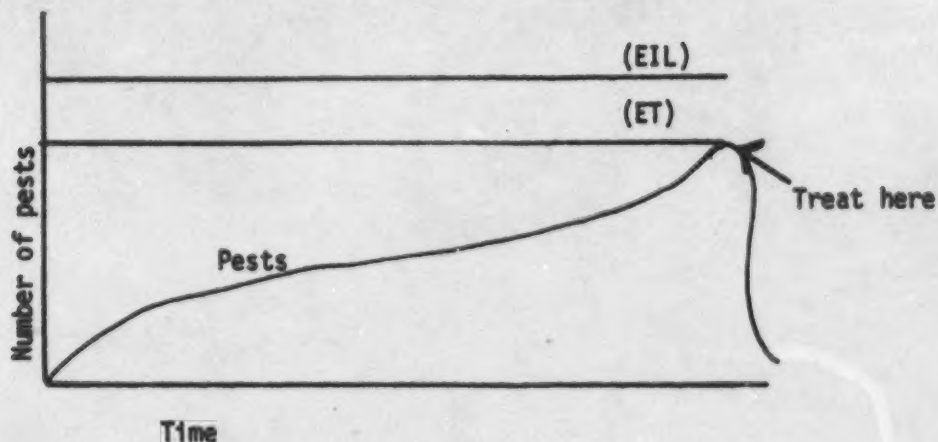
1. By scouting crops for pests, growers can find out if a pest problem exists.
2. If pests are found, the scout can count them, record their numbers and sizes and tell how bad the problem is.
3. Scouting can also tell growers of natural controls such as pest predators, parasites or pathogens are present.
4. Once pests have been counted, the grower can decide if any action is needed.
5. If something needs to be done, the scout's report can be used to decide what action to take.
Should pesticides be used? What pesticide to use? How much? Can other control methods be used? etc.

HANDOUT

MEASUREMENTS USED IN MONITORING PESTS

Economic Threshold Level:

(ET) - This is a population level that is about to become big enough to do economic damage to a crop. It is also called the "Action Threshold" because it is the time when something should be done. If pest populations get beyond this level, a farmer's profits will be reduced.



Economic Injury Level

EIL - This is the population level where economic damage is being done. If pests are not treated before this point they will reduce profits. Every day that pests remain at this level, the farmer loses money. Pest populations should not be allowed to reach this point.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: SCOUTING, MONITORING AND FORECASTING

MODULE: INSECT PESTS

STUDENT PERFORMANCE OBJECTIVE	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. Write in 100 words or less, the steps involved in scouting a field for insect pests.	Scouting steps - select sample area - take sample - identify insects and sizes - count insects - check plants for damage - record numbers	Read handout: <u>Scouting for Insect Pests.</u>
2. List three factors to consider before applying pesticides for damage done by insects.	Before applying pesticides, determine - number of insects - type of insects - size of insects - leaf area index (percent of leaves damaged by insects) - stage of crop growth	Read handout: <u>When to Spray?</u> Read and discuss handouts, <u>Florida Peanut Pest Management Field Report</u> , <u>Florida Soybean Pest Management Field Report.</u>
3. Scout a field for insect pests.	Shake cloth-beat method	Discuss: Insects that are pests for other crops. Take class to the land laboratory to scout for insects. Use shake cloth and record numbers. Have class make up field reports similar to the peanut and soybean reports. Discuss findings and determine what action should be taken.

HANDOUT

SCOUTING FOR INSECT PESTS

There are several different methods of scouting for insects. The method used will depend on the crop and the insects being scouted for.

The most common method of scouting for foliage feeding insects is the shake cloth method. The scout lays a white cloth between the rows of plants, the plants are then bent in over the cloth. The scout shakes and beats the plants to knock any insects onto the cloth.

When looking for underground insects that feed on roots or stems, the scout must uncover the roots of a plant to check for insects and damaged roots.

There are some basic steps that are followed, for any method the scout uses to look for insects.

First the scout selects the sample area. At least four samples are taken from each field, more if the field is large. Now the scout takes the sample. This can involve shaking the plants or digging up roots or both.

Identifying the insects and classing them according to size is the next step. Large caterpillars eat more than small ones, so it is important to know how many of them are large or small.

Now the scout counts each type and determines the size of insect. This must be done quickly since they will be trying to get away. This is a good time to check for plant damage, such as partially eaten leaves.

Next the scout records the number of each type of insect that was counted and size class. The scout is now ready to move to the next sample site.

HANDOUT

WHEN TO SPRAY?

There are many factors that a grower must think about when deciding whether or not to spray insects.

In order to save energy, farmers should spray only when absolutely necessary. Scouting helps to tell the farmer when pesticides are needed and when they are not.

Here are some of the factors that should be used in making the decision.

- Number of insects - Crops can have some insects on them without any real damage being done.
- Type of insects - Some insects are more damaging than others. Some are beneficial
- Size of insects - Big caterpillars eat a lot. Small caterpillars eat only a little.
- Leaf Damage or Leaf Area Index (LAI) - Some crops can stand to have more of their leaves eaten than others.
- Stage of Crops Growth - The amount of insects it takes to damage a plants yield will depend on whether the plant is a seedling, mature, flowering or fruiting.

Recommendations for when to spray will depend on all these things. Contact your county agent to find out if you should spray or not.

FLORIDA PEANUT PEST MANAGEMENT FIELD REPORT

HANDOUT

COMMENTS

Grower _____

Field Name & # _____

Scout _____

Date _____

Time _____

Acres _____

	LCSB	SCRW	Leafspot	VBC	AW	CEW	OTH	CW
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
TTL								

Pod Feeders

LCSB Infested Sites _____

SCRW Infested Sites _____

Total Leaf Feeders _____

AW,CEW,Etc. _____ Size _____

Cutworms _____ Size _____

Plant Diameter in. _____

Worm Size 1 2 3 4 5 6

- 1
 - 2
 - 3
 - 4
 - 5
 - 6

Leaf Feeders

Total Leaf Feeders _____

Total Ft. of Row Sampled _____

Total Cut Worms _____

Total Feet of Row Sampled _____

Pod Feeders

Total LCSB Infested Sites _____

Total Sites Inspected _____

Total SCRW Infested Sites _____

Total Sites Inspected _____

Planting Date _____

1st Fungicide Application _____

Leaf Feeders
Per Row Ft.

Cut Worms
Per Row Ft.

% LCSB Infested
Sites

% SCRW Infested
Sites

Total % LCSB &
SCRW
Infested Sites

Grower	Field Name and #								
Scout	Date	Time	Acres						
	CEW	FAW	VBC	LP	BAW	GCW	OTH	SBL	SBS
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
TTL									

Total Leaf Feeders 0 1 2 3 4 5 6

Total Pod Feeders 1 2 3 4 5 6

Total Large Stinkbugs

Worm Size
 1
 2
 3
 4
 5
 6

Plant Hgt.
 Pre-Bloom 1/2 Pod Fill
 Bloom Pods Full
 Pods 1/2-1"

Pre-bloom

Total All Worms
 Total Ft. of Row Sampled

Leaf Feeders
 Per Row Foot

Post Bloom (Pods > 1/2")

Total Leaf Feeders
 Total Ft. of Row Sampled

Leaf Feeders
 Per Row Foot

Total Pod Feeders
 Total Ft. of Row Sampled

Total Pod Feeders
 Per Row Foot

Total Large Stinkbugs
 Total Ft. of Row Sampled

Total Large
 Stinkbugs
 Per Row Foot

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: SCOUTING, MONITORING AND FORECASTING

MODULE: NEMATODES

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. Identify three symptoms of nematode damage. 2. Sample a field for nematodes, handle and package the sample according to state nematology lab specifications, given equipment (soil probe, bucket, plastic bags).	Irregular shaped spots of stunted growth Discolored, faded or yellowed plants Areas in which plants wilt faster than the rest of the crop Take soil sample, fill out assay forms, package samples, mail samples to: Nematodes Assay Laboratory Building 78, IFAS University of Florida Gainesville, FL 32611	Read handout: <u>Scouting Fields for Nematodes.</u> Transparency, <u>A Plant Parasitic Nematode.</u> Discuss: Adverse effects of nematodes. If possible bring in plants with nematode damage or show slide/cassete set Nematode Control, IFAS Editorial. Read handout: <u>Florida Nematodes Sample Kit.</u> Students will go to the land lab with soil sampling equipment and take samples for nematodes according to the handout. Obtain nematode sample kits from your county extension office.

HANDOUT

SCOUTING FIELDS FOR NEMATODES

Late summer, when crops such as soybeans and peanuts are fairly well developed but not yet completely mature, is an excellent time to scout fields for evidence of nematode injury.

Irregularly-shaped spots of stunted growth, off-color plants, and areas which wilt earlier and worse than other parts of the field should be examined for nematode injury to the roots. Location of such spots and identification of the cause of the problem at this time gives the grower a long time to plan for its management for following seasons.

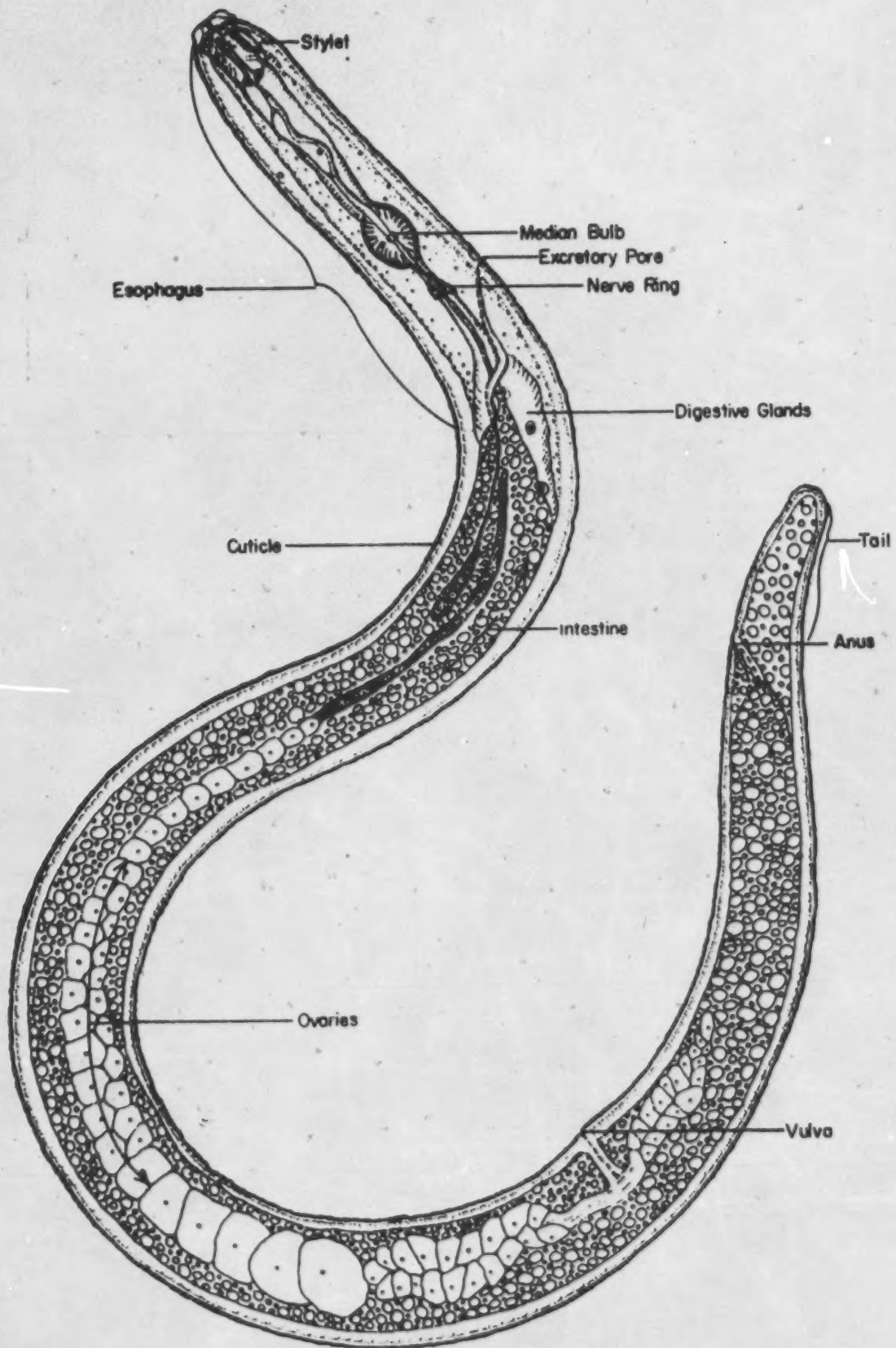
If root-knot nematodes are part of the problem, be sure to get the species identified (It is certainly peanut root-knot nematode if the problem is on peanuts, but four different species can occur on soybeans in Florida).

If the grower has nematode samples taken in late summer, he has all winter to plan his program of rotation, resistant varieties, and for selection of the best pesticides to efficiently control that problem.

Recognition of a soybean cyst nematode infestation at this time of year will help the grower avoid carrying cysts from that infested area to the rest of his land during harvest operations, by leaving infested areas until last, or destroying them without harvest.

In agriculture, as in many other human activities, there is a great deal of truth to the old adage, "An ounce of prevention is worth a pound of cure."

A PLANT PARASITIC NEMATODE



FLORIDA NEMATODE SAMPLE KIT

Some nematode problems can be accurately diagnosed in the field, but laboratory analysis of soil and roots is usually necessary to confirm field observations. Following are instructions for collecting and submitting samples to the Florida Nematode Assay Laboratory. Follow instructions carefully to be sure that the sample reaches us in good condition so you get accurate information from it.

INSTRUCTIONS

Enclosed are this instruction sheet, a plastic bag, a pre-addressed cardboard box, a Nematode Assay Record Form (4 sheets, no carbon required) and an envelope. If submitting a number of samples, use the carton as a guide to the sample size, even though it will be more convenient to ship samples in a larger carton.

1. The sample should be prepared from a mixture of 10 to 20 "cores" of soil. Cores are most easily taken with a soil-sampling tube, auger, or trowel. A shovel may be used by cutting a 1-inch thick slice of soil through the soil profile and discarding all but a 1 to 2-inch vertical band from the slice. It is often best to discard the top 1 inch from each core, since nematode numbers may be very low there.

2. Where to sample. When diagnosing a problem of growing plants, always sample near living roots of the plants for which diagnosis is needed. It may be helpful to submit an additional sample from an adjacent area of good growth for comparison. Sample only when soil moisture is appropriate for working the field; avoid extremely dry or wet soil conditions for best results. Specific directions for different crops are as follows:

a. Annual crops (most vegetables, annual ornamentals, and field crops) - take soil from root zones of 10-20 affected plants that are not yet dead. Include "feeder" or fine roots from several of them. Remove the surface inch of soil before taking each core 6-8 inches deep.

b. Fruit and nut trees, perennial shrubs and trees - if many plants are affected, include cores of subsamples from several of them in the sample. If only one or a few are affected, take several cores from around each plant. Use a spade or shovel to dig down within the "drip-line" (the area covered by the branches) to find fine feeder roots. Each subsample or "core" should consist of a few fine roots and soil from immediately around them. Discard roots and soil from the surface inch. For burrowing nematode of citrus, collect roots and soil from below 12 inches.

c. Turf grasses and forage crops - collect 10 to 20 cores from declining, but not yet dead, areas. Collect cores 3-4 inches deep in the root zone of the desired plant species, avoiding bare spots and weeds.

d. Advisory or predictive sample - This is a sample taken to predict the likelihood of nematode injury to the next crop to be planted in the field. Nematodes are most numerous and easiest to detect near the end of the preceding cropping season. Advice for spring crops often best based on samples taken in October or November. This kind of sample should be representative (average) of the entire sampling area. Collect cores in a regular pattern over the area. One sample should represent no more than 10 acres for relatively low-value crops such as corn and soybeans, and no more than 5 acres for higher valued crops such as vegetables, peanuts, and tobacco. Areas which have different soil types or which were planted to different crops (or varieties) during the past season should be sampled separately.

3. Mix cores together carefully, then remove 1 quart to place in the plastic bag enclosed with this kit. Include as many fine roots as possible (up to 1/2 cup) mixed in with the soil sample. A 1-quart sample in the plastic bag will just fit into the box which is in this kit. Seal the sample in the bag with a rubber band or twist-tie. Label the outside of the bag with your name and a sample number or other identification so that the lab can not confuse your sample with that of someone else. Label the bag by writing directly on it with a permanent black felt-tip marker or with a permanent pen or pencil on masking tape stuck to the bag. Do not place a paper label inside the bag with the soil -- it will decompose rapidly and may be unreadable when opened in the lab.

4. Handling and Submission. Nematodes will die from overheating, freezing, or drying. Do not leave samples exposed to sunlight, or carry them in a hot car trunk or on the dashboard. Do not add water to the sample, even if it seems dry to you. Just package and send it so we get it in the same condition as when you collected it. If nematodes are killed in handling, they can not be recovered in the laboratory, and you will receive false results.

5. Complete the Nematode Assay Record form with all requested information. Print or write clearly and press hard enough to be sure that your information is clearly legible on all four copies of the form. Be sure that your sample numbers and the information on the form are correctly matched. Complete information about cropping history and plans, symptoms, etc. will help us make a more accurate diagnosis and recommendation. Accurate identification of the plant species (and variety, if possible) for which a diagnosis is needed is absolutely necessary to make a recommendation.

6. Packing and payment. Use the two pieces of gummed tape to assemble the enclosed pre-addressed box. Put the Assay Form, any correspondence about the problem, and payment for running the samples in the envelope and put it in the box with the plastic bag of soil. Each sample costs \$5.00. Please do not send cash. Make check or money order payable to "Florida Nematode Assay Service." **THE SAMPLE WILL NOT BE PROCESSED IF THE FEE IS NOT PAID.**

7. Mail, ship, or deliver samples to the Nematode Assay Laboratory as quickly as possible. The mailing address is printed on the sample box and on the Nematode Assay Record Form. For those who prefer to deliver samples to the Laboratory, it is located on Mowry Road, south of Lake Alice on the University of Florida campus. Our telephone number is (904) 392-1990 if you need help to find us. Please deliver samples between 8:00 a.m. and 5:00 p.m.

Services

The sample will be analyzed to determine the identity to genus and numbers of each kind of plant parasitic nematode. These results and the appropriate recommendations will be written on the Nematode Assay Record form. You and your County Extension Agent will each be sent a copy of the Record form no later than 10 working days after receipt of the sample in the Laboratory.

In some instances, identifying nematodes to species is necessary to select the best manage program. The Nematode Assay Service will identify pests to species when possible, if needed for management decisions. This may require 8 weeks additional time, to culture the organism in question. When such a delay is required, the normal report will be returned within 10 days after sample receipt, and a supplementary report will be provided when final results are available.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: SCOUTING, MONITORING AND FORECASTING

MODULE: PLANT DISEASES

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. List three conditions that must be monitored in order to forecast plant diseases. 2. Write two ways that energy can be saved by monitoring or forecasting.	Regular scouting for disease symptoms Spore traps Monitoring weather conditions - wind - rain - humidity - temperature Monitoring plant diseases saves energy. - use fungicides only as needed - gain control of diseases early - help plan cultural programs to reduce diseases in problem areas	Read handout: <u>Monitor Plant Diseases to Save Energy.</u> Discuss: What are some benefits to be gained by monitoring plant diseases? Read handout: <u>Monitoring and Forecasting Plant Diseases.</u> Show slide/cassete set "Crop Diseases" IFAS Editorial. Activity: Obtain U.S. Weather Service data from previous seasons. Use this data to draw a chart of probable high disease periods. Have students complete <u>Evaluation.</u>

HANDOUT

MONITOR PLANT DISEASE TO SAVE ENERGY

Plant diseases, especially some types of fungus can be very destructive to crop plants. Once a disease begins to spread in a field it becomes hard to control. Farmers have long known the importance of disease control. To keep crop diseases from reaching destructive levels, large amounts of fungicide are used. By spraying often, growers could prevent outbreaks of such diseases as blight, stem rot, leafspot and rust on many crops. Using pesticides for prevention, however requires a lot of energy both to make the chemical and to apply it.

Farmers are now finding that they can save much of this energy by scouting fields for diseases and by using new methods of forecasting when the disease will break out. If a disease is found in the field, or it is forecasted to break out, the grower will want to spray. If no disease is present, and it is not expected to break out, the grower can stop spraying. By spraying only when needed instead of on a regular schedule, the farmer can save large amounts of money and energy. Reducing the amount of fungicides used will save the energy used to make the chemicals. Reducing the number of applications will reduce the total amount of fuel used.

Examples

Here are some examples of how much energy can be saved.

Forecasting methods were used for early blight fungus on 5,000 acres of Florida celery in one year. In the months of November, December, January and February, an average of two spray applications per week were eliminated. This resulted in a savings of 340,000 pounds of fungicide. The fuel for the airplanes used to apply the chemical was also saved. This added up to 13,452 gallons of airplane fuel saved in one year.

An example of energy waste was with the control of late blight disease in potatoes during 1975. Scientists using forecasting methods, recommended five fewer applications than were actually used. If those five applications would have been eliminated, 184,000 pounds of fungicide and 32,400 gallons of diesel-fuel used to operate tractors for application of the chemical would have been saved.

HANDOUT

MONITORING AND FORECASTING PLANT DISEASES

There are several factors that influence the growth and spread of plant disease. Weather conditions are especially important. By closely monitoring daily changes in the weather, scientists can predict how much fungus will be growing each week. Fungus disease spreads by tiny seeds called spores. These are carried by the wind. They will grow and reproduce if they land on a favorable surface such as a plant leaf.

Most fungi grow best in warm and humid weather. Cool nights or dry air will slow fungus growth. Florida has a very warm and humid climate. Conditions here are often very good for the growth of fungus disease, especially during the summer. Heavy rainfall will slow the growth of fungus by washing the spores off of the leaves. The weather conditions that are monitored for predicting the outbreak of fungus disease are, temperature, humidity, wind and rainfall.

The amount of spores in the air can also be used in forecasting disease outbreak. A spore trap is used. A spore trap is simply a tube that faces into the wind with a greased microscope slide inside. As air flows through the tube some of the spores are stuck to the slide. They can be counted under a microscope.

By keeping close track of windspeed, rainfall, temperature and humidity and by counting the spores daily, a grower can forecast when fungus diseases will spread.

EVALUATION

INTRODUCTION

1. List two ways that scouting or monitoring pests can save energy in agriculture.
2. Give three reasons for scouting or monitoring crop pests.
3. Define economic threshold and economic injury level.
4. Name one other benefit (besides energy conservation) that can be gained from scouting.
5. Write, in 100 words or less, the steps involved in scouting a field for insect pests.
6. Identify three factors to consider before applying pesticides for damage done by insects.

NEMATODES

7. Name three symptoms of nematode damage.
8. Outline the methods uses in scouting a field for nematodes.
9. List three conditions that must be monitored in order to forecast diseases.
10. Write two ways that energy can be saved by monitoring or forecasting the occurrence of plant diseases.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: PREVENTATIVE PEST CONTROL PRACTICES

MODULE: RESISTANT VARIETIES

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. Describe, in writing, how farmers can save energy by planting resistant or tolerant varieties.	Resistant crop varieties save energy - eliminate or reduce need for chemical treatment - eliminate or reduce need for other control methods, cultural, etc. - reduce pest populations by providing less favorable conditions for them to grow. Resistance and tolerance to disease, insects, and nematodes.	Read handout: <u>How Resistant Plant Varieties Save Energy in Pest Management.</u> Read handout: <u>Pest Resistance and Tolerance.</u> Activity: Each student will be given the handout <u>Crop Information Worksheet</u>. Assign one crop commonly grown in the area to each student. The student will complete the worksheet for their crop.

HANDOUT

HOW RESISTANT PLANT VARIETIES SAVE ENERGY IN PEST MANAGEMENT

Plant breeders have been able to develop special strains or varieties of crops that are not affected by certain pests. These are called resistant varieties (RV). Some varieties are also available that are affected by pests but are not seriously damaged. These are called tolerant varieties.

Resistance to diseases, insects or nematodes can save much of the energy used to control these pests.

If a crop is resistant to a pest, the farmer does not need to apply chemicals for that pest. Less spraying of pesticides means less energy use.

Cultural methods, such as deep plowing or sanitation, are often used to control pests. If the crop is resistant to those pests, the cultural controls will not be needed. Large amounts of fuel energy can be saved.

Resistant varieties can also save energy by reducing pest populations. If a corn plant is resistant to a certain pest, that pest will not be able to use it for food. If all the corn plants in the county are resistant, that pest will not have very much to eat. The population of that pest will shrink. This can mean less energy used to control that pest in other crops.

Some crop varieties are resistant to certain insects and nematodes. Disease resistance however is most common. Here are some examples of energy savings from disease resistant varieties.

Examples of energy savings can be calculated for certain plant diseases in Florida. Watermelons are grown successfully without soil fumigation because varieties resistant to Fusarium wilt are available. Using the 1974 Florida watermelon acreage and a rate of 35-40 gallons of multipurpose fumigant per acre, 1.75 to 2 million gallons of fumigant would have been needed if resistant varieties were not planted. And using a 75 hp tractor fumigating 8-foot swaths, 17,188 hours of tractor time would have been required during which 65,750 gallons of diesel fuel would have been consumed, for just this one production practice.

Southern corn leaf blight on field corn has been controlled primarily by using varieties with N cytoplasm, a particular type of cell structure that provides a high degree of resistance to the fungus causing this disease. If fungicides were used to control this disease instead of RV, 3,582,000 pounds of fungicides would have been needed for the 1974 field corn acreage in Florida alone. Also, using a 450 hp aircraft to deliver the fungicide would have required 139,300 gallons of fuel.

HANDOUT

PEST RESISTANCE AND TOLERANCE

Plant breeders spend a great amount of time and effort developing pest resistant crop plants.

These resistant varieties are a vital part of an overall pest management plan. Without the resistant or tolerant varieties now available, our pesticide use would be much greater.

Resistance to disease is most common. More disease resistant varieties have been developed than insect or nematode resistant. There are varieties of many field crops, vegetables, and fruit trees that are resistant to various diseases.

Insect resistance is a little harder to come by. Some crops can be bred to be less desirable to certain insects. These usually are not totally resistant. Even partial resistance will result in less pest damage and less spray needed.

Varieties of several crops have been bred for resistance to nematode pests. Soybeans resistant to cyst nematodes are now planted in many areas. Research is being done to develop nematode resistance in other crops.

A farmer can save a lot of time, money and energy by planting pest resistant varieties. Before buying seed, it is a good idea to find out what pests of that crop are present in your areas first. Then you can try to buy seed for a variety that is resistant to some of those pests.

CROP INFORMATION WORKSHEET

CROP

	PEST RESISTANT OR TOLERANT VARIETIES	PESTS THAT EACH VARIETY IS RESISTANT TO	OTHER CHARACTERISTICS OF VARIETY
1)			
2)			
3)			
4)			
5)			

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: PREVENTATIVE PEST CONTROL PRACTICES

MODULE: CULTURAL PRACTICES

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. List five cultural practices that can help save energy in a farm pest management system. Write one paragraph about each and explain how it conserves energy.	Cultural Practices - Crop rotation - Sanitation - Tillage practices - Trap crops - Fertility and water management	Read handout: <u>Cultural Practices for Pest Prevention</u>. Discuss transparency, <u>Theory of Crop Rotation</u>. Activity: Students will write a brief summary of cultural practices used on their farms. These practices will be discussed by the class in terms of pest management and energy efficiency.

HANDOUT

CULTURAL PRACTICES FOR PEST PREVENTION

By preventing pest outbreaks from even occurring, a grower can save much of the fuel and chemicals that would be needed to control them later. Careful planning of cultural practices on the farm can keep pests from ever reaching destructive levels.

Sanitation

This means destroying the food and shelter that pests will use between crops. Sanitation can be very effective in controlling some insects, diseases and nematodes.

Insect and nematode eggs as well as fungus and viral diseases may be living in a crop residue after harvest.

Residue or stubble from certain crops should be cut up and turned under as soon as the crop has been harvested. This will cause rotting and will prevent pests from using the material for food.

Sanitation can also mean cleaning farm machinery after use to prevent the spread of insects, nematodes, diseases and weed seeds from one field to another.

Destruction of Alternate Hosts

Some native plants or weeds are used by pests when crop plants are not available. It is a good idea to find out which plants these pests, especially insects and diseases, live on and destroy them.

Also, some very serious weeds may be growing outside a field. The grower should find these and cut them down before they seed a crop field. Ditches and fence rows should be checked occasionally for weeds.

Crop Rotation

Some insect eggs, nematodes, diseases and most weed seeds remain dormant in the soil over the winter. If the crop that is planted the next year is a good host, i.e. provides good food and shelter for the pest, the pests will emerge and become more plentiful.

Crop rotation means never planting the same crop in the same field twice in a row. If one crop is a good host for a certain pest, the field should be planted with a poor host the following season.

This keeps the pests from ever reaching a population level where they become serious.

Crop rotation has been successful in controlling certain insects and diseases in corn, nematodes in soybeans and many others.

You can plan crop rotations for your farm that will save energy by preventing pests from ever getting established.

Tillage

How and when various tillage practices are carried out, can have an effect on pest populations.

Planting dates can be very important in protecting plants from insects and weeds. Planting as early as possible can help many spring crops to gain an advantage before insects hatch or weeds germinate. Some crops can be planted late, with planting being delayed until certain pests die or go dormant. A grower should consult with his county agent and other growers for information on timing of planting dates.

Row spacing and seeding rates can also influence pest populations. Narrow rows in soybeans and peanuts have been found to increase yields by shading out weeds. If weeds cannot compete with the crop plants, herbicide applications and energy use can be reduced.

In row subsoiling, a method of cutting a deep slot in the soil beneath the row, seems to benefit the plant in competing with nematodes. By opening up an uninfested area of soil below the "plow pan", subsoiling can promote vigorous root growth. This will reduce the effects of nematodes for at least the first season, until the area becomes infested.

Minimum tillage practices, which save energy by reducing fuel consumption in field preparation and planting, can complicate pest management. Increased use of pesticides is often necessary. However, minimum tillage often allows earlier planting, and for that reason has the potential of reducing pest problems somewhat.

Trap Crops

One more cultural method that can save energy on the farm is the use of trap crops. By planting a few early rows on each side of a field, a grower can draw insects into a small area for treatment. These rows are planted such that they ripen several weeks ahead of the rest of the field. Insects will be attracted to the ripening plants. These rows can then be sprayed before the insects spread to other areas. This has been used in cotton.

Small plots of non-crop plants can also be planted to trap insects if plants that are more desirable to the pests can be found.

Fertility and Water Management

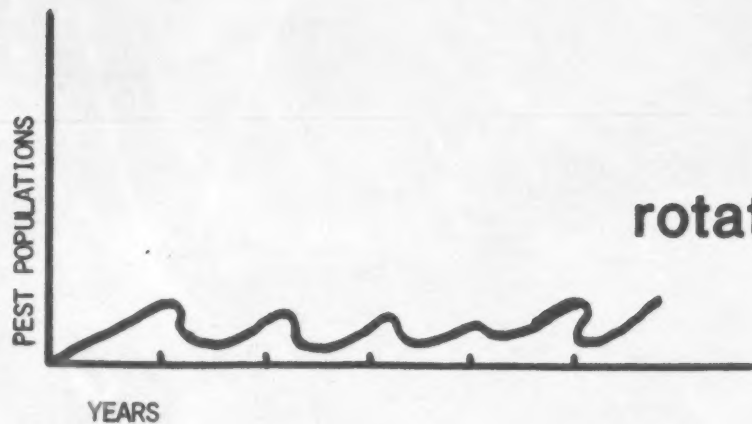
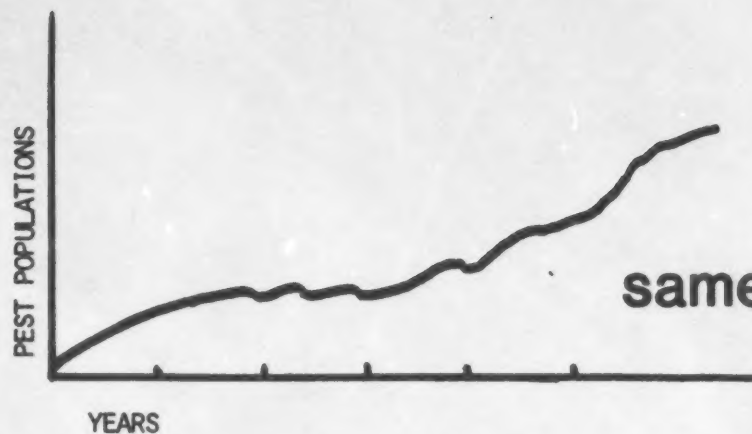
Helping to give a crop a strong competitive advantage over various pests can greatly reduce the need for chemical treatment.

Proper fertility and soil moisture can help give crops this advantage. Soil testing and fertilizer recommendations will aid in determining what your soil and crops need.

Proper timing of fertilizer applications will give crops the most benefit and keep you from fertilizing weeds.

Irrigation needs to be timed and regulated as well, to give crop plants the full benefit.

THEORY OF CROP ROTATION



LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: PREVENTATIVE PEST CONTROL PRACTICES

MODULE: REGULATORY PEST CONTROL

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. List four regulatory control measures which help save energy.	Inspection Quarantine Certification of seeds & root stock Sanitation	Read handout: <u>Regulatory Pest Controls-Save Energy through Prevention</u> Resource person: Invite an agricultural inspector from the USDA or Division of Plant Industry to speak to the class about regulatory measures taken to control pests. Have students complete <u>Evaluation</u>.

HANDOUT

REGULATORY PEST CONTROLS-SAVE ENERGY THROUGH PREVENTION

Anytime a weed, insect, or disease begins to cut into farmers' yields and profits, energy use increases. Energy already invested in preparing the land, planting, fertilizing and irrigating the crop is lost to pests. Control measures such as cultivation, chemical applications and field sanitation all use energy. Regulatory controls can often prevent pests from being introduced into an area or from spreading to new areas. Since the pest never becomes a problem, energy does not need to be used in its control.

Here are some of the low energy regulatory methods that can be used to prevent pest outbreaks.

1. Inspection - the USDA and Florida Division of Plant Industry inspect plants, animals and seeds entering the state from other states or from overseas. Plants and animals are inspected for diseases and parasites. Seeds are inspected for diseases, nematodes and weed seeds that may be present. Fruits and vegetables are also inspected to make sure they are not carrying any pests that could spread to Florida crops.
2. Quarantine - Plants and animals entering or leaving the state can be held for observation. Some may be carrying diseases, insect eggs or other pests that cannot be seen. By holding these for a set period of time, authorities can be sure that they are pest free before they are released.
3. Certification of seed and rootstock - Programs to inspect and certify seeds and rootstock have been going on for some time. If farmers can buy seed or rootstock knowing that it is free of weed seeds, diseases and nematodes, they can reduce the amount of energy needed to control these pests.
4. Sanitation - Farm implements, ships, airplanes, trucks and other types of machinery have been blamed for spreading pests. Anything that could carry plant or animal diseases, insects, weed seeds or nematodes should be thoroughly cleaned before being allowed into the state. Much of this is already being done, especially with food shipments from other states or from overseas.

All of these regulatory measures contribute to save energy in pest control. It is often said that prevention is the best medicine. This is certainly true in pest management. It is hard to measure how much is saved through pest prevention but we can be sure that without some regulatory controls our energy use would be much greater.

EVALUATION

1. List five cultural practices that can help save energy in a farm pest management system. Write one paragraph about each explaining how it saves energy.
2. Write in 50 words or less, how farmers can save energy by planting resistant or tolerant varieties.
3. List four regulatory control measures which help save energy.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: NATURAL CONTROLS

MODULE: BIOLOGICAL PEST CONTROL

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. List the three classes of organisms used in biological control of pests. 2. Write, in 50 words or less, how natural or biological control organisms can help conserve energy. 3. Write, in 100 words or less, how pesticides interfere with natural controls and two ways to prevent this.	Natural or biological controls - predators - parasites - pathogens Biological control organisms can be used to control pests which could reduce the amount of pesticides or other control methods that are used. Pesticides - kill beneficial hosts as well as pests Prevention measures - don't use pesticides - reduce amount used - use selective pesticides	Read handout: <u>Biological Control of Pests</u>. Discuss: Examples of natural control organisms in your locale. Read handout: <u>Bio-control and Energy</u>. Read handout: <u>Pesticides and Natural Control</u>. Activity: Collect pest insects such as caterpillars or aphids. Introduce natural enemies to these insects and observe the effects. Some biological controls that can be introduced are baccillus on caterpillars, lady beetles with aphids and parasitic wasps with fly larva. Show films: Slide/cassete set, "Biological Control of Florida Insects" Instructional Materials Service - IFAS. Film "Natural Citrus Pest Control", IFAS Editorial. Have students complete <u>Evaluation</u>.

HANDOUT

BIOLOGICAL CONTROL OF PESTS

Biological control is making use of organisms that kill or weaken pests naturally. Nature has its own ways of keeping populations from getting too large.

Pests or natural enemies used in biological control.

1. Predators - one species which eats other species as its food supply.
 - cats eat mice
 - ladybugs eat aphids
 - fish eat mosquito larvae
 - spiders eat flies
2. Parasites - organisms that feed upon a host.
The host may be killed or weakened by the parasites.
 - wasps lay eggs on caterpillars, wasp larvae feed on its body
 - fleas feed on dogs
3. Pathogens - disease organisms that infect the pest.
These are very small single-celled creatures and may include fungi, bacteria or virus. Some of these pathogens can be used by farmers to control harmful insects. One good example is the fungus "Bacillus Thuringiensis" which is harmless to man and animals but very effective in controlling harmful caterpillar pests.

HANDOUT

PESTICIDES AND NATURAL CONTROL

Pesticides can be a great tool in the control of pests. They can also cause problems.

One of these problems is that pesticides often kill beneficial predators, parasites and pathogens as well as pests. When these beneficial organisms are killed, the pests can increase their own numbers very quickly.

This means that more pesticides will need to be applied more often to keep pests under control. The more pesticides growers apply the more energy there is used.

There are many ways that pesticides can interrupt natural controls. One well known instance is when insecticides are applied to cotton to kill the cotton boll worm and boll weevil. Many of the predators and parasites of these insects are also killed by the chemical. Pests can then actually increase in number. Another example is when fungicides are applied to vegetables to kill plant diseases. There are fungi present which control caterpillars that are pests on that same crop. The fungicide applied controls both the helpful and harmful fungi. This results in an increased number of caterpillars.

How can growers keep from killing these natural control organisms?

- a. Avoid using chemical pesticides.
 - use cultural methods, resistant varieties, etc. to reduce pest populations.
 - scout or monitor pests carefully, watch for both beneficial and harmful organisms.
 - spray only when it becomes absolutely necessary.
- b. Reduce the amount and frequency of pesticide applications.
 - sometimes a small dose of pesticide will kill the pests but not harm the beneficial organisms.
- c. Use selective pesticides.
 - some chemicals can be used to kill only specific pests without harming the beneficial organisms.

EVALUATION

- 1) List the three classes of organisms used in natural or biological control or pest.

- 2) Write, in 50 words or less, how natural or biological control organisms can help conserve energy in agriculture.

- 3) Write, in 100 words or less, how pesticides interfere with natural controls and two ways to prevent this.

LOW ENERGY TECHNOLOGY
CROP PROTECTION FOR INTEGRATED PEST MANAGEMENT

UNIT: CHEMICAL CONTROLS

MODULE: READING THE LABEL

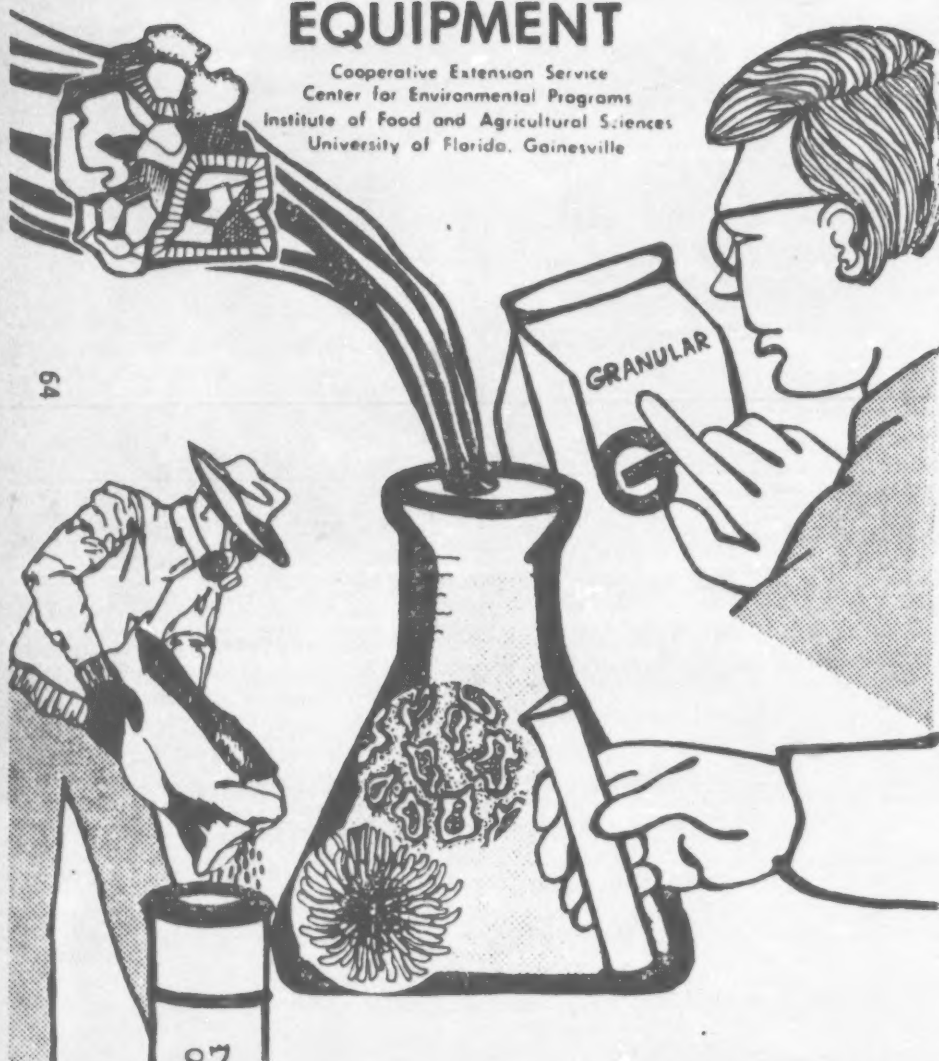
STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: Given examples of pesticide labels, write the type of pesticide, formulation, storage and disposal precautions, toxicity category, amount of active ingredient, application restrictions, and crops and pests it can be used on.	Label information: - Product name - Kind of pesticide - Formulation: - form - percent active ingredients - Storage & disposal precautions - Toxicity category - Use - crops - pests - Rates of application - Restrictions	Read handouts: <u>Pesticides, Formulations and Equipment, Labels and Labeling, and Four Keys to Pesticide Safety.</u> Show and discuss transparencies <u>Pesticide Label, Types of Formulations, Signal Words.</u> Activity: Have students collect pesticide labels or pictures of labels. Pass out labels in class and have each student complete the <u>Pesticide Label Information Sheet</u> for two pesticide labels. Show slide/cassette presentation "Safe Use of Pesticides, The Label and You", IFAS Editorial.

PESTICIDES

FORMULATIONS AND

EQUIPMENT

Cooperative Extension Service
Center for Environmental Programs
Institute of Food and Agricultural Sciences
University of Florida, Gainesville



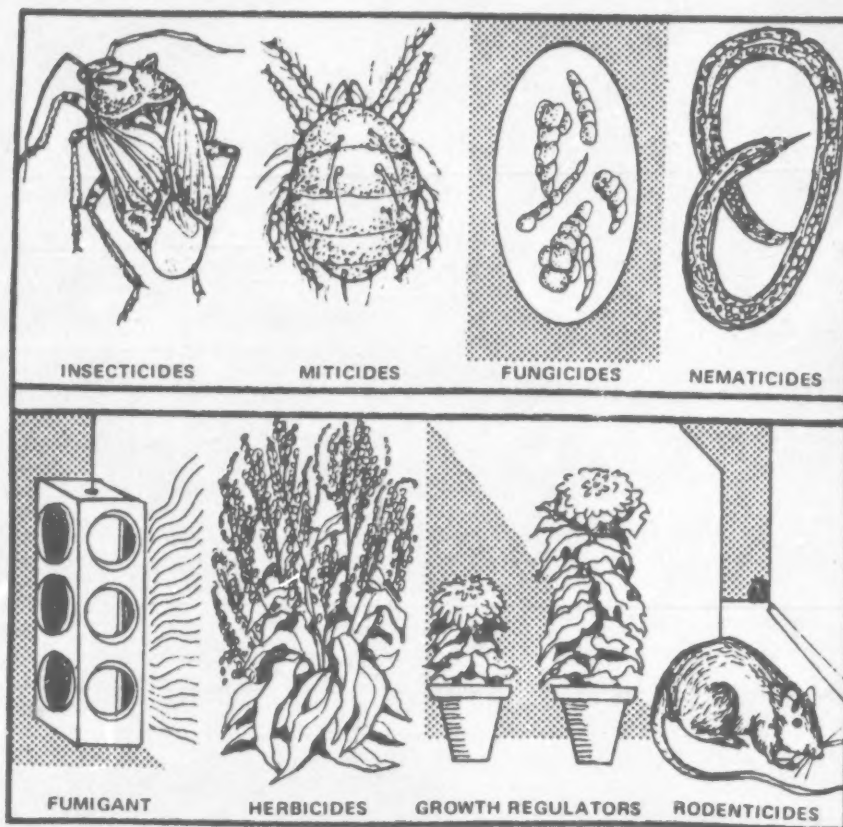
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PESTICIDES

What is a pesticide? It is a chemical used to control a pest. The most important kinds of pesticides are listed below.

- INSECTICIDES:** Insecticides control insects and their relatives the spiders, and similar pests.
- MITICIDES:** A miticide controls mites, a close relative of insects.
- FUNGICIDES:** A fungicide is used to prevent or control a plant disease caused by a fungus.
- NEMATICIDES:** This type of pesticide controls nematodes.
- FUMIGANT:** This pesticide controls pests by giving off a gas or vapor.
- HERBICIDES:** This group of pesticides controls unwanted plants (weeds). Herbicides are often called "weed killers."
- GROWTH REGULATORS:** These pesticides change the growing or fruiting habits of a plant.
- RODENTICIDES:** Rodenticides control rodents.



INSECTICIDES

MITICIDES

FUNGICIDES

NEMATICIDES

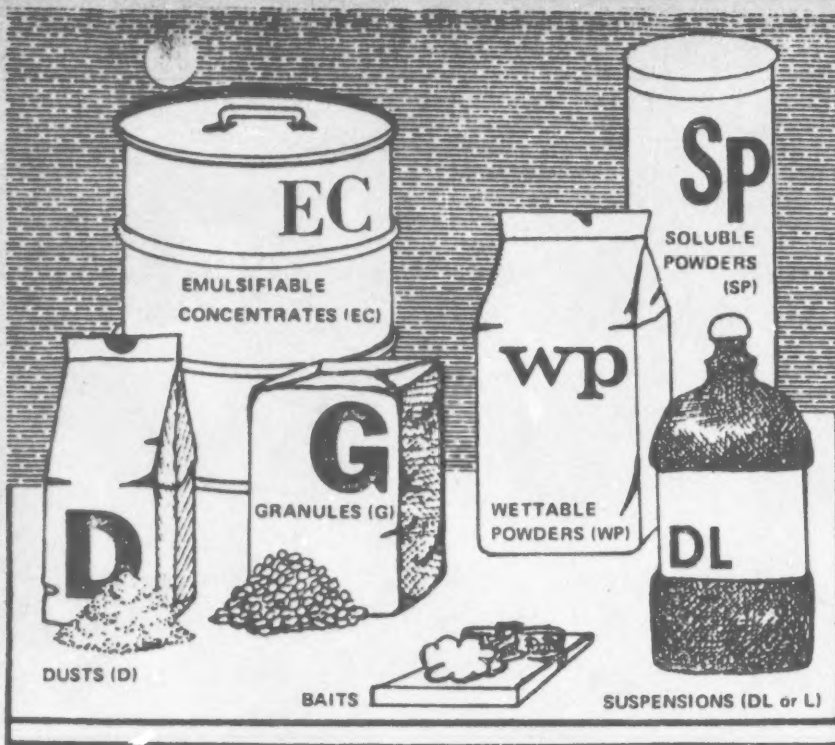
FUMIGANT

HERBICIDES

GROWTH REGULATORS

RODENTICIDES

88



PESTICIDE FORMULATIONS

There are several forms (also called formulations) of pesticides.

Dusts (D) and Granules (G) are dry pesticides that are already mixed and ready to apply when you buy them.

Wettable Powders (WP) or Soluble Powders (SP) may look like dust, but they are not used like a dust. While a dust is ready to use when you buy it, a wettable powder or soluble powder must be mixed with water before using. Wettable powders usually form a cloudy liquid after being mixed, while soluble powders are usually clear in water. Wettable powders need to be constantly stirred or shaken during use to avoid settling out.

Baits kill pests that feed on them. Some are bought ready-to-use, but others must be mixed with a dry or wet substance to attract the pests to them.

Emulsifiable Concentrates (EC) and Suspensions (DL or L) are liquids that are mixed with water or oil to form a spray liquid.

Here are some ways pesticide formulations appear on the label and what they mean:

Formulations	Meaning
5D	5% Dust
10G	10% Granular
50WP or 50W	50% Wettable Powder
6EC or 50E	6 pounds per gallon Emulsifiable Concentrate
4DL or 4L	4 pounds per gallon Suspension
90EC - Fumigant	90% active (turns into gas)

GENERAL USE PESTICIDES

If a pesticide will harm the applicator or the environment very little or not at all when used exactly as directed, it can be called a general use pesticide. The label on these products will say "General classification."

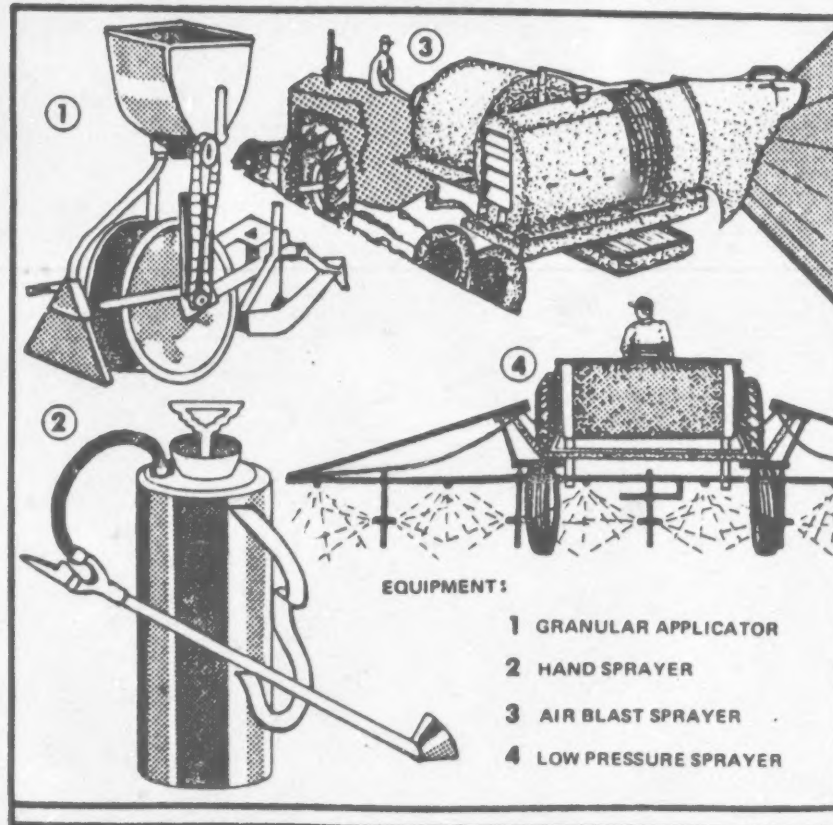
RESTRICTED USE PESTICIDES

A restricted use pesticide is one which could cause some human injury or environmental damage even when used as directed on the label. The label on these products will say:

RESTRICTED USE PESTICIDE

FOR RETAIL SALE TO AND APPLICATION ONLY BY
CERTIFIED APPLICATORS OR PERSONS UNDER THEIR
DIRECT SUPERVISION

The restricted use statement must be at the top of the front panel of the label.



EQUIPMENT:

- 1 GRANULAR APPLICATOR
- 2 HAND SPRAYER
- 3 AIR BLAST SPRAYER
- 4 LOW PRESSURE SPRAYER

SUNSHINE STATE PESTICIDE PROGRAM

This public document was promulgated at an annual cost of \$459.15, or 2.3¢ per copy to inform Florida producers of proper pesticide use.

HANDOUT

Each time you buy a pesticide, you also receive instructions to tell you how to use it. Those instructions are the labeling.

What is labeling? What is a label? These words seem alike but they do not mean the same thing.

Labeling is all information that you receive from the company or its agent about the product. Labeling includes such things as:

- the label on the product,
- brochures,
- flyers, and
- information handed out by your dealer.

It must agree with what the manufacturer told the Environmental Protection Agency (EPA) about the product.

The *label* is what is printed on or attached to the container of pesticides. This label does many things:

- To the manufacturer, the label is a "license to sell."
- To the State or Federal Government, the label is a way to control the distribution, storage, sale, use, and disposal of the products.
- To the buyer or user, the label is a main source of facts on how to use the product correctly and legally.
- The label is a way to tell users about special safety measures needed.

Some labels are easy to understand. Others are complicated. But all labels will tell you how to use the product correctly. This section will explain the items that must be on a label.

PARTS OF THE LABEL

Brand Names

Each company has brand names for its products. The brand name is the one used in ads. The brand name shows up plainly on the front panel of the label. It is the most identifiable name for the product.

Common Name

Many pesticides have complex chemical names. Some have been given another name to make them easier to identify. These are called *common names*. For instance, carbaryl is the common

LABELS AND LABELING



POISON



protects:

flowers

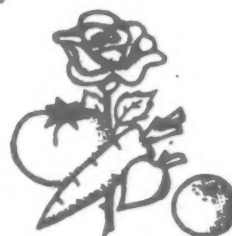
roses

fruit

shrubs

tomatoes

vegetables



Contains Diazinon*

CAUTION:

Keep out of reach of children.
See additional caution statements on back of container.

NET CONTENTS

30 GAL.

name for 1-naphthyl N-methylcarbamate. A chemical made by more than one company will be sold under several *brand names*, but you may find the same *common name* or chemical name on all of them.

Ingredient Statement

Every pesticide label must list what is in the product. The list is written so that you can see quickly what the active ingredients are. The amount of each *active ingredient* is given as a percentage by weight or as pounds per gallon of concentrate. It can be listed by either the chemical name or the common name. The *inert ingredients* need not be named, but the label must show what percent of the contents they make up.

Net Contents

The net contents number tells you how much is in the container. This can be expressed in gallons, pints, pounds, quarts, or other units of measure.

Name and Address of Manufacturer

The law requires the maker or distributor of a product to put the name and address of the company on the label. This is so you will know who made or sold the product.

Registration and Establishment Numbers

A registration number is on every pesticide label. It shows that the product has been registered with the Federal Government. It usually is found on the front panel of the label and will be written as "EPA Registration No. 0000." The establishment number tells what factory made the chemical. This number does not have to be on the label, but will be somewhere on each container.

Human Hazard Warnings

To do their job, most pesticides must control the target pest. By their nature, most of them are toxic. Therefore, some may be hazardous to people. You can tell the toxicity of a product by reading the *signal word* and looking at the *symbol* on the label.

Signal Words

One of the most important parts of the label is the *signal word*. It tells you approximately how toxic the material is to people. The signal words



ACTIVE INGREDIENT: *PESTOFF - 40.50%
INERT INGREDIENTS: 59.50%
TOTAL: 100.00%

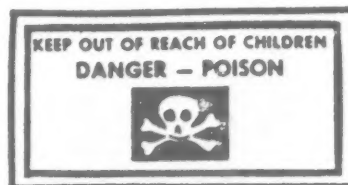
*TRI-SALICYLIC ACID

NET CONTENTS ONE GALLON



MFG BY A-Z CHEMICALS
TOWN, STATE

ESTABLISHMENT NO. 00475
EPA REGISTRATION NO. 135742



⑤

One of the best ways to catch a person's eye is with symbols. This is why a skull and crossbones symbol is used on all highly toxic materials along with the signal word DANGER and the word POISON.

Pay attention to the symbol on the label. It is there to remind you that the contents could make you sick, or even kill you.

All products must bear the statement, "Keep Out of Reach of Children."

Pesticides are useful tools. But wrong or careless use could cause undesirable effects. To help avoid this, the label contains environmental precautions that you should read and follow.

Here are some examples:

- "This product is highly toxic to bees exposed to direct treatment or to residues on crops."
- "Do not contaminate water when cleaning equipment or when disposing of wastes."



WARNING Flammable liquid and vapor.
Keep from heat or open flame.

- "Do not apply where runoff is likely to occur."

Labels may contain broader warnings against harming birds, fish, and wildlife.

Physical and Chemical Hazard Statement

This section will tell you of any special fire, explosion, or chemical hazards that the product may pose

Statement of Practical Treatment

The label will:

- tell you emergency first aid measures,
- describe the signs and symptoms of poisoning, and
- give instructions to a physician if the product is highly toxic.

The pesticide label is the most important information you can take to the physician when you think someone has been poisoned.

Statement of Use Classification

Every pesticide label must show whether the contents are for general use or restricted use. EPA puts every product use into one of these two classes. The classification is based on:

- the hazard of poisoning,
- the way the pesticide is used, and
- its effect on the environment.

General Use

If a pesticide will harm the applicator or the environment very little or not at all when used exactly as directed, it can be called a general use pesticide.

The label on these products will say:

"General classification."

Restricted Use

A restricted use pesticide is one which could cause some human injury or environmental damage even when used as directed on the label. The label on these products will say:



CAUTION

**KEEP OUT OF REACH OF CHILDREN
EXTREMELY HAZARDOUS LIQUID AND
VAPOR UNDER PRESSURE • INHALATION
MAY BE FATAL OR CAUSE DELAYED LUNG
INJURY • LIQUID AND VAPOR CAUSE
BURNS WHICH MAY BE DELAYED.**

**Do Not Breathe Vapor • Use Only With Adequate
Ventilation • Do Not Get in Eyes, on Skin, on Clothing
Do Not Use Ordinary Rubber Protective Clothing
including Gloves and Boots • Keep Away From Heat.**

**SEND FOR A DOCTOR IMMEDIATELY
IN CASE OF EXPOSURE**

FIRST AID

IF INHALED—Carry Patient to Fresh Air • Call a Physician at Once • Make Sure Patient can Breathe Freely • Keep Patient Warm • Give Artificial Respiration if Breathing has Stopped • Oxygen should be Administered Only by Qualified Personnel

IN CASE OF CONTACT—Immediately Remove All Contaminated Skin Covering including Shoes, Clothing, and Adhesive or other Bandages • Wash Skin Thoroughly with Soap and Water if Irritation or Blisters Develop • Get Medical Attention For Eyes • Flush Immediately with Plenty of Water for at Least 15 Minutes and Get Medical Attention • Do Not Reuse Shoes or Clothing until Free of All Contamination

NOTE TO PHYSICIAN: Keep Patient at Rest and Under Observation for 24 to 48 Hours

**DO NOT SPILL OR DISCHARGE CONTENTS OUTSIDE OF AREAS
CONFINED FOR TREATMENT • KEEP CHILDREN AND ANIMALS AWAY
FROM AREAS UNDER TREATMENT** 273

NOTICE: Seller warrants that the product conforms to its chemical description and is reasonably fit for the purposes stated on the label when used in accordance with directions under normal conditions of use, but neither this warranty nor any other warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE, express or implied, extends to the use of this product contrary to label instruction, or under abnormal conditions, or under conditions not reasonably foreseeable to seller, and buyer assumes the risk of any such use



"Restricted use pesticide for retail sale to and application only by certified applicators or persons under their direct supervision."

The restricted use statement must be at the top of the front panel of the label.

Directions for Use

The instructions on how to use the pesticides are an important part of the label for you. This is the best way you can find out the right way to apply the product.

The use instructions will tell you:

- the pests the product is registered to control (Labels use common names for pests. Knowing these names will help you choose the proper pesticide and find control information),
- the crop or animal the product can be used on,
- whether the product is for general or restricted use,
- in what form the product should be applied,
- how much to use,
- where the material should be applied, and
- when it should be applied.

Reentry Statement

If required for the products, this section will tell you how much time must pass before a pesticide-treated area is safe for entry by a person without protective clothing.

Category of Applicator

If required for the product, this section will limit use to certain categories of commercial applicators.

Misuse Statement

This section will remind you that it is a violation of Federal law to use a product in a manner inconsistent with its labeling. Do not use

RESTRICTED USE PESTICIDE

FOR RETAIL SALE TO AND APPLICATION ONLY BY
CERTIFIED APPLICATORS OR PERSONS UNDER THEIR
DIRECT SUPERVISION



DIRECTIONS FOR USE

PEANUTS (Southern Stem and Root Rot—*Sclerotium rolfsii*): Preplant Soil Mix: Apply 13 to 20 lbs. per acre as a spray in an 8 to 12 inch band centered on the row, and mix to a depth of 2 to 4 inches. Application may be made simultaneously with planting, using suitable application equipment.

Soil Mix During Cultivation: Apply in split applications during three cultivations at the rate of 4 to 7 lbs. in 15 to 20 gals. of water per acre per application.

Attach two spray nozzles per row ahead of inside cultivator sweeps (one on each side) and adjust so as to treat a total band of 12 inches wide centered on the row. Do not pile untreated soil on crown of plant.

Surface Band Treatment: Apply 13 to 20 lbs. per acre as a dust in a 12 inch band centered on the row, at pegging time. Where cultural practices permit, this may be mixed and applied simultaneously with land-plaster.

NOTE: Do not feed treated vines to livestock.

POTATOES (*Rhizoctonia solani*) —Broadcast treatment: use 33 lbs. per acre prior to planting. Disc and cross disc to a depth of 4 to 6 inches.

In Row Treatment (in-furrow) use 13½ lbs. per acre mixed with approximately 20 gallons of water (per 13,000 linear feet of row based on 40 inch spacings, or to 14,500 linear feet based on 36 inch rows). Spray several points in the planting row to treat all the soil that surrounds and covers the seed piece and potato forming zone. Three nozzles attached to the planter work best; one fan nozzle ahead of opening discs (approximately 3 gals. of spray per acre); one cone nozzle placed above and slightly ahead of closing discs (approximately 10 gals. of spray per acre); one fan nozzle to rear of closing discs (approximately 5 gals. of spray per acre). Spray pattern should treat a 12 to 14 inch band centered on the row.

TOMATOES AND PEPPERS (Southern Blight—*Sclerotium rolfsii*): Field use only. Transplant Solution: Mix 3 to 5 lbs. in 100 gals. of water and apply ½ pt. per plant at the time of transplanting. The solution should be agitated often to maintain a uniform suspension and assure proper dosage.

Trench Spray: Apply 10 lbs. in 100 gals. of water per acre over opened "V" trench just before setting transplants. Set plants in bottom of trench; then press walls of trench against stems of the young transplants.

NOTE: When cultivating, set plows as flat as possible to avoid getting untreated soil against stems of plants.

a product on a crop or for a pest not listed on the label. Do not use it at more than the recommended rate. Before the product could be registered, EPA required the manufacturer to conduct many tests to be sure the label directions were correct. By following them exactly, you will:

- get the best results the product can give, and
- avoid breaking the law.

Statement of Storage and Disposal Precautions

Every pesticide should be stored and disposed of properly. This section will tell you how to store and dispose of the product.

PENALTIES

You may be breaking the law if you do not use a pesticide as directed on the pesticide label. You may be fined up to \$5,000 even though you did not *intend* to break the law. Anyone who *knowingly* misuses a pesticide is guilty of a criminal offense. On conviction he could be fined up to \$25,000 and put in prison for up to one year.

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.



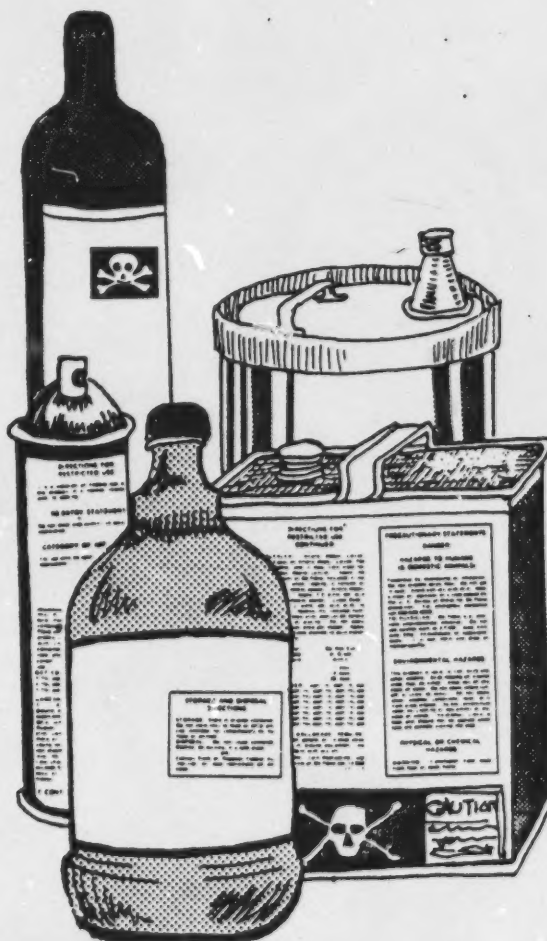
STORAGE AND DISPOSAL DIRECTIONS

STORAGE: Store in original container. Do not store near food or other use and intended for consumption by the user or animal.

DISPOSAL: Do not reuse container. Destroy by burning in a safe place.

OR

Contact State or Regional Federal Air Agency for local restrictions on use.



Four Keys to Pesticide Safety



READ THE LABEL ON EACH PESTICIDE CONTAINER BEFORE EACH USE. Follow instructions; heed all cautions and warnings.

STORE PESTICIDES IN THEIR ORIGINAL, LABELED CONTAINERS. Keep them out of the reach of children and irresponsible people. Lock pesticides in a shed away from feed, seed, and other farm supplies.



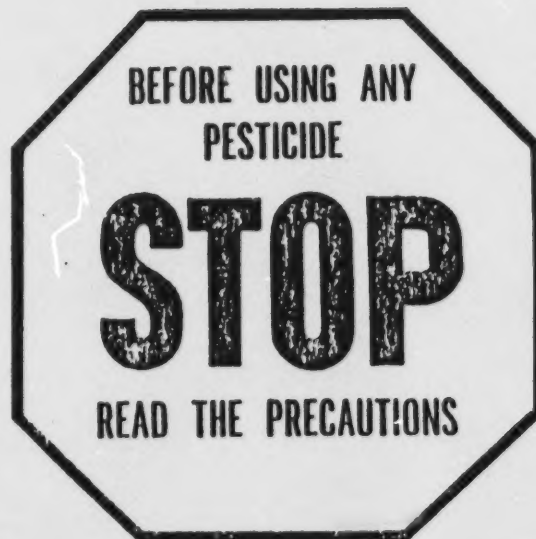
APPLY PESTICIDES AS DIRECTED. Apply them only to the crops specified, in amounts specified, and at times specified by your agricultural authorities or on the label.

DISPOSE OF EMPTY CONTAINERS SAFELY. Florida regulations require labels to carry instructions for decontamination and disposal of empty containers of highly toxic pesticides.



READ AND HEED THESE INSTRUCTIONS

HANDOUT



PESTICIDE LABEL

PRECAUTIONARY
STATEMENTS
HAZARDS TO HUMANS
(& DOMESTIC ANIMALS)
CAUTION

ENVIRONMENTAL HAZARDS

PHYSICAL OR CHEMICAL
HAZARDS

DIRECTIONS FOR USE

GENERAL CLASSIFICATION

It is a violation of Federal law to use this
product in a manner inconsistent with
its labeling.

RE-ENTRY STATEMENT
(If Applicable)

STORAGE AND
DISPOSAL

STORAGE

DISPOSAL

CROP

PRODUCT
NAME

ACTIVE INGREDIENT _____ %
INERT INGREDIENTS _____ %

TOTAL _____ 100.00%

THIS PRODUCT CONTAINS LBS. OF PER GALLON

KEEP OUT OF REACH OF CHILDREN

CAUTION

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED _____

IF INHALED _____

IF ON SKIN _____

IF IN EYES _____

SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS

MFG BY _____

TOWN, STATE _____

ESTABLISHMENT NO. _____

EPA REGISTRATION NO. _____

NET CONTENTS _____

CROP _____

CROP _____

CROP _____

CROP _____

CROP _____

WARRANTY STATEMENT

PESTICIDE LABEL

PRECAUTIONARY
STATEMENTS
HAZARDS TO HUMANS
(& DOMESTIC ANIMALS)
CAUTION

ENVIRONMENTAL HAZARDS

PHYSICAL OR CHEMICAL
HAZARDS

DIRECTIONS FOR USE

It is a violation of Federal law to use this
product in a manner inconsistent with
its labeling.

RE-ENTRY STATEMENT
(If Applicable)

STORAGE AND
DISPOSAL

STORAGE

DISPOSAL

CROP

RESTRICTED USE
PESTICIDE

FOR RETAIL SALE TO AND APPLICATION ONLY BY
CERTIFIED APPLICATORS OR PERSONS UNDER THEIR
DIRECT SUPERVISION

PRODUCT
NAME

ACTIVE INGREDIENT _____ %

INERT INGREDIENTS _____ %

TOTAL _____ 100.00%

THIS PRODUCT CONTAINS LBS. OF _____ PER GALLON

KEEP OUT OF REACH OF CHILDREN
DANGER—POISON



STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED _____

IF INHALED _____

IF ON SKIN _____

IF IN EYES _____

SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS

MFG BY _____

TOWN, STATE _____

ESTABLISHMENT NO. _____

EPA REGISTRATION NO. _____

NET CONTENTS _____

CROP _____

CROP _____

CROP _____

CROP _____

CROP _____

WARRANTY STATEMENT

Types of Formulations

Dry

Dust (D)

Poisonous Bait (B)

Granule (G)

Wettable Powder (WP or W)

Soluble Powder (SP)

Gas

Fumigant

Solutions

Aerosol (Pressurized Can)

Aerosol (Generator)

Low Concentrate Solution (S)

Emulsifiable Concentrate
Solution (EC or E)

Ultra-Low Volume Concentrate
Solution (ULV)

Flowable (F)

Signal Words

DANGER



POISON

WARNING

Moderately Toxic

CAUTION

Highly Toxic

Slightly Toxic to
Relatively Nontoxic

HANDOUT

PESTICIDE LABEL INFORMATION SHEET

	<u>Pesticide A</u>	<u>Pesticide B</u>
1) Name of pesticide	1)	1)
2) Kind of pesticide	2)	2)
3) Formulation	3)	3)
4) Storage and disposal precautions	4)	4)
5) Toxicity category	5)	5)
6) Amount of active ingredient	6)	6)
7) Application restrictions	7)	7)
8) Crops it can be used on	8)	8)
9) Pests it will control	9)	9)

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: CHEMICAL CONTROLS

MODULE: PESTICIDES AND ENERGY

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. List three ways that pesticides contribute directly or indirectly to overall energy use.	Pesticides and energy - Petroleum products used in making pesticides - Fuel used in application - Energy used to manufacture and maintain equipment - Transportation of chemical and equipment Treadmill effect - destruction of beneficial organisms, emergence of new pests, etc.	Read handout: <u>Pesticides and Energy</u>. Show film, "The Insect Alternative" IFAS Editorial.

HANDOUT

PESTICIDES AND ENERGY

Pesticides are an important part of our agricultural system. Large amounts of energy and money are invested in producing a crop. Tilling the land, planting, fertilization, all require the use of diesel fuel and other energy sources. Using pesticides can be thought of as insurance, protecting the crop from losses due to destructive pests.

Pesticides can help save energy by protecting the farmer's investment. They also act to increase energy use. Anytime a farmer can reduce the use of chemical pesticides without loss of yields, energy will be saved. Here are some of the ways that pesticides can add to energy use.

- Most pesticides are petroleum products. They are made with petroleum and also need fuel to provide heat for their production. The production of pesticides uses about three times as much petroleum as the application.

- Applying chemical pesticides to a crop requires direct use of energy on the farm. Most farmers using pesticides must spray two or three times per growing season. This results in the use of from .65 to 2.0 gallons of diesel fuel per treated acre each year.

- Manufacturing equipment, sprayers and parts, etc. requires a large energy input. Saving on the use of a tractor or any implement will result in longer life of the machine and less replacement parts. This is an indirect savings of energy.

- Transportation of agricultural chemicals requires large amounts of energy. Most of this is diesel fuel which is becoming scarce and more expensive. Transportation of equipment could be considered in the overall energy use of agricultural pesticides.

- There are many side effects, that can result in further energy use when pesticides are applied. Often beneficial organisms that help control pests are destroyed. This results in a "treadmill effect" where the farmer must continuously spray to keep ahead. Some fungicides used to control disease in soybeans and corn have been found to also kill some fungi that are parasites on several insect pests. This results in a buildup of these insects when the fungicide is used.

- Another problem that can arise is the resurgence of pests resistant to the chemical you are using, or the emergence of new pests that were controlled by competition but are allowed to populate when chemicals are sprayed.

You can see from these examples that energy can be saved when pesticide use is reduced. Several methods can be used to keep pests from causing serious damage. However, pesticides are often the best or only way to control destructive crop pests. By applying chemicals only when needed, applying the proper rate and the proper type of chemical, a grower can use pesticides efficiently. By protecting a crop in the field, and all the time, money and energy invested in it, a farmer can see real long term energy savings.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: CHEMICAL CONTROLS

MODULE: PESTICIDE APPLICATION

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. List four precautions that can be taken to assure the effectiveness of chemical pesticide with as little waste as possible. 2. List three different types of spray nozzles and describe the spray pattern from each nozzle. 3. List and define six major parts of a sprayer.	There are many things for the grower to consider before and during the application of pesticides. To get the full benefit of any chemical while conserving energy, the grower should do the following: - determine need - decide on pesticide to use - read and follow label directions - maintain spray equipment - calibrate the sprayer - carefully apply the pesticide. Types of Nozzles - solid (full) cone nozzle - hollow cone nozzle - regular flat fan nozzle - solid stream nozzle Major parts of a sprayer. - tank - pumps - strainers - hoses - pressure gauges - pressure regulator - agitators - control valves - nozzles	Read handout: <u>Using Pesticides Efficiently</u>. Plan a pesticide application program. Complete handout <u>Pesticide Checklist</u> to determine if proper precautions have been taken. Transparency <u>Types of Nozzles</u>. Disassemble a sprayer and lay out the parts. Each student should be able to identify each part and correctly reassemble the sprayer so that it works as per the manufacturers specifications. Read handout: <u>Sprayer Parts</u>.



HANDOUT

Using Pesticides Efficiently

F.A. Johnson - Extension Entomologist

ENERGY CONSERVATION FACT SHEET

University of Florida • Institute of Food and Agricultural Sciences

The petroleum shortage has extended to and affected to a great degree those who use pesticides or depend upon them. Petroleum derivatives are used as necessary raw materials in the production of almost 100 percent of modern pesticides used in the U.S. at present. Many other petroleum derived chemicals are also needed as intermediate products in manufacturing pesticides.

As a result of the petroleum shortage, the prices of needed agricultural chemicals have significantly risen in the last several years. To add further pressure to the cost of using pesticides, other industries outside agriculture have also needed the same fuels and the same intermediate and primary petroleum products that the pesticide industry must have.

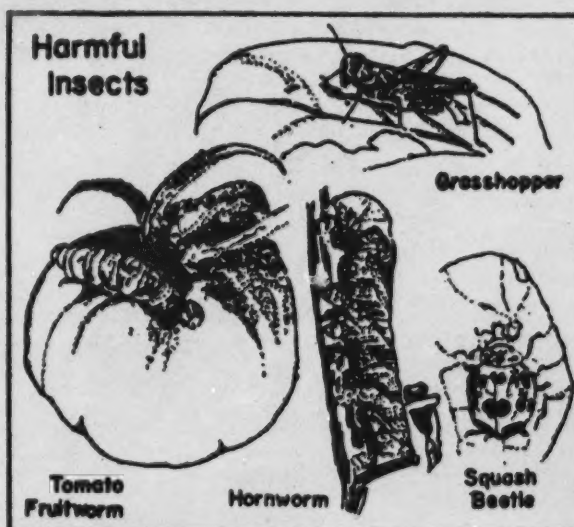
In applying pesticides, there is more to consider than just the cost of the material being applied. The farmer or user must consider these points: (1) the amount of fuel used to drive his equipment; (2) the price of labor used in making the application; (3) the cost of maintenance and overhead of the application equipment. In many cases, these three items far outweigh the cost of the pesticides being applied.

WHAT CAN BE DONE?

The success of many operations often revolves around



Insects left unchecked can destroy crops



the understanding and application of a few basic rules. In the use and application of pesticides, particularly insecticides, several basics become major concerns. These basics can be referred to as the 5 R's. They are:

- (1) Use the Right insecticide for the job.
- (2) Use the insecticide in the Right amount.
- (3) Apply the insecticide in the Right way.
- (4) Apply the insecticide at the Right time.
- (5) Know the Right identification of the insect.

A basic understanding and knowledge of these 5 R's is going to become more and more important if the modern day agriculturist is to be successful. Application of the 5 R's will result in more efficient use of energy since energy expended is directly related to the time and cost of production.

How can a pesticide user apply the 5 R's to his situation? The following outline will be helpful as an introduction, but each pesticide user must continually seek to understand these principles if he is to optimize his efficiency.

(1) - How is the Right material determined?

Many sources of information exist: (1) The county Cooperative Extension Service maintains up-to-date manuals, circulars and recommendations on specific crops and pests in your area and offers technical help. (2) Dealers and suppliers of pesticides have written information available. (3) Other farmers or peers in a specific area can offer advice. They can be contacted through growers' associations, etc.

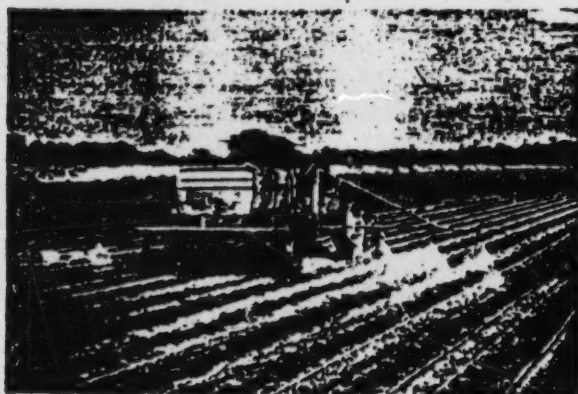
(2) - What is the Right amount?

The right amount also can be found from the same sources as listed in (1). Also, the label on the pesticide should be carefully read as being the best source of information on correct amounts. Use caution and do not overdose. If a little is good, a lot is not necessarily better. You could have a crop confiscated by the Food and Drug Administration or the State Department of Agriculture for overdosing. Penalties for overdosing can range from having to rewash crops to having the entire crop destroyed. Even rewashing can cause financial loss because of the time and labor involved. Perishability is also a problem when extra time is taken for rewashing.

In addition, be sure to buy proper measuring devices. Many errors can be made when small amounts are used.

(3) - What is the Right way?

This principle is probably the most often violated one of the 5 R group. This violation results in poor or no control, overdosing, wastage, and loss of energy, time and money. It is imperative to do several things. (1) Calibrate your spray equipment carefully and regularly. Remember, a 10 percent error is magnified in time, money, and labor over an entire season. Instructions on how to calibrate can be obtained from your local County Extension Director or agricultural supply dealer. (2) Choose the proper equipment for the job and keep it clean. Use care in selecting good quality nozzles, strainers, discs and other items used in spraying. (3) Carefully adhere to the recommended uses of pressures and speeds. Remember, a slight increase in pressure or reduction in desired ground speed results in more spray used. (4) Constantly check for leaks in your system, and replace worn discs. A worn disc can apply a great deal more spray than you want. (5) Excessive speed in spraying is false economy. To have to do a job over because of failure to get control, costs twice as much in materials, labor and energy. In the meantime, the unprotected crop is subject to loss due to insect damage.



Grower applying pesticides

(4) - When is it the Right time for action?

This is probably the most difficult question to answer. It is best approached by becoming familiar with your particular crop and the pests specific to your area. It is necessary to obtain research information through the university systems or other research (via Cooperative Extension Service) on thresholds of damage that your crop can stand before you have economic loss. In the past, if one worm was seen, it was "one too many," and the sprayer was put into action. Pesticide shortage and costs prohibit this practice under present economic conditions. The grower is encouraged to do several things: (1) He should scout or examine each of his fields on a weekly or, better, on a twice weekly basis. (2) He should know his pests and their habits. He must consider whether pests are hurting his crop or just eating insignificant amounts of foliage. (3) He should attend growers' meetings and seek the latest information on how to scout particular crops. Haste in spraying can often be waste.

(5) - What is the Right name of the pest?

The grower can identify his own pests most of the time. Many states now have training sessions where the grower can learn. Bulletins and circulars put out by the Cooperative Extension Service have descriptions and photographs to properly aid the grower. If in doubt, the grower should contact his County Extension Director for proper identification. Recent research has shown that one species of worm cannot be treated as another species. Specific insecticides and specific amounts must be used for specific pests. Misidentification can lead to selection of the wrong material. Not only is the pest uncontrolled, it continues to damage a crop making repeat applications necessary. It is easy to see that costs can soon double or triple if pests are not identified correctly.

In addition to pesticides, much literature and training can be obtained in manipulating beneficial organisms in our environment to control pests. These beneficial organisms include types of mites, insects, numerous arthropods, friendly fungi and certain bacteria. These beneficial organisms prey on and destroy the harmful pests that destroy crops.

Today's grower is urged to use modern pest management. That is, he should use the correct varieties, consider planting times, use cultural techniques, spray only when needed, observe the 5 R's and destroy crop residues after harvest. This total approach to pest control is proving an effective way to reduce costs and energy inputs, increase yields, and provide the public with a better and safer product.

3-5M-76

COOPERATIVE EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS
(Act of May 8 and June 30, 1914)
Cooperative Extension Service, IFAS, University of Florida
and United States Department of Agriculture, Cooperative
Joe H. Shady, Dean

PESTICIDE CHECKLIST

Determine Need

- ☐ 1. Pest is properly identified.
- ☐ 2. Threshold level has been reached.
- ☐ 3. Other control methods ruled out.

Pesticide to use

- ☐ 1. Pesticide is cost-effective (profit will be higher if applied than not applied).
- ☐ 2. Chemical is compatible with crop.
- ☐ 3. Persistence of chemical is known
- ☐ 4. Residual activity will not harm next crop.
- ☐ 5. Pesticide is known to be effective on pest in question.

Label

- ☐ 1. Restrictions understood.
- ☐ 2. Proper rates are calculated.
- ☐ 3. Hazards understood.
- ☐ 4. Crop and pests in question are listed.

Sprayed maintenance

- ☐ 1. Proper nozzle tips.
- ☐ 2. Tips checked for wear, even distribution.
- ☐ 3. Nozzle tips are clean.
- ☐ 4. Pump operates at proper pressure.
- ☐ 5. Hoses are unobstructed.

Sprayer calibration

- ___ 1. Gallons per acre determined.
- ___ 2. Recommended amount of chemical in tank.

Application

- ___ 1. Proper boom height.
- ___ 2. Correct speed determined.
- ___ 3. Pumping pressure is known
- ___ 4. Spray pattern is even and uniform.
- ___ 5. Time is good for application - pests are susceptible etc.
- ___ 6. Weather conditions are right - low wind, moderate temperature, no rain.

Types of Nozzles

**Solid (Full)
Cone Nozzle**



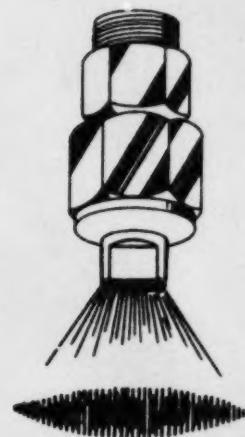
**Hollow
Cone Nozzle**



**Flooding Flat
Fan Nozzle**



**Regular Flat
Fan Nozzle**



Solid Stream Nozzle

HANDOUT

SPRAYER PARTS

Tanks

Tanks should have large openings for easy filling and cleaning. They should allow straining during filling and have mechanical or hydraulic agitation. The tank should be made of corrosion-resistant material such as stainless steel or it should have a protective lining or coating. The tank should have a drain for cleaning. The outlets should be sized to the pump capacity. If you use dual tanks, make sure the plumbing allows for agitation and adequate withdrawal rates in both tanks. All tanks should have a gauge to show the liquid level.

Flush out the tank, pump, lines, and nozzles after each day's use and each separate pesticide use. If switching to another pesticide where contamination must be prevented, wash out with detergent and water two or three times and then flush with water. Phenoxy herbicides such as 2,4-D are hard to remove. After using them, either follow the special cleaning procedures noted on the pesticide label or avoid using the same sprayer for any other product. Keep tank clean inside and out. Tighten or repair all leaky tank seals or fittings. Make sure sight gauges can be read.

Pumps

The pump must be adequate for all the spraying pressures you use. It must provide enough flow to:

- supply all nozzles,
- allow for hydraulic agitation when needed, and
- leave a reserve to allow for loss of flow due to wear.

Pumps should resist corrosion and abrasion. Centrifugal pumps provide high volume at low pressure. They are not self-priming. Piston and diaphragm pumps provide moderate to high volumes at high pressure. They are self-priming. Roller and gear pumps provide moderate volume at low to moderate pressure. They are self-priming in most equipment. Do not use wettable powder formulations in gear pumps. If you need pressures above 75 psi, piston pumps are more likely to provide them over a long period of time.

You will damage a pump if you operate it dry or with a restricted inlet. Follow the manufacturer's recommendations for pump operation. Keep all shields in place.

Strainers

Proper filtering of the pesticide:

- protects the working parts of the sprayer, and
- avoid time loss and misapplication due to clogged tips.

Atomizing Nozzle - Makes a fine mist for liquid pesticides. Used indoors in special situations.

Broadcast - This nozzle forms a wide flat fan pattern. It is used on boomless sprayers and to extend the effective swath width when attached to the end of a boom.

Many spraying jobs could be done by more than one nozzle type or pattern. Here are some general guidelines.

For weed control:

- regular flat fan
- flooding fan
- even flat fan
- hollow cone

For disease control:

- hollow cone
- solid cone

For insect control outdoors:

- regular flat fan
- hollow cone
- solid cone

For insect control indoors:

- even flat fan
- solid stream
- atomizing

To minimize drift:

- flooding fan
- whirl chamber hollow cone
- keep operating pressures below 30 psi

You can get nozzles in many materials. Here are the main features of each kind.

Brass:

- inexpensive
- wears quickly from abrasion
- probably the best materials for limited use

Stainless Steel

- will not corrode
- resists abrasion, especially if it is hardened

Plastic:

- resists corrosion and abrasion
- swells when exposed to some solvents

Aluminum:

- resists some corrosive materials
- is easily corroded by some fertilizers

Tungsten carbide and ceramic:

- highly resistant to abrasion and corrosion
- expensive

Keep nozzles in good working condition. For most boom applications, select nozzles of uniform type and size.

Nozzle caps should not be over-tightened. Adjust nozzle distance and spacing to suit the target. Follow the nozzle manufacturer's instructions and the pesticide label. Allow for crop or weed height if necessary. Check each nozzle for uniform flow using water and a jar marked in ounces. Replace any whose flow is 5 percent more or less than average. Replace any nozzles having faulty spray patterns. A good check is to spray on asphalt pavement. Watch for streaks as you increase speed or as spray dries.

Clean nozzles only with a toothbrush or wooden toothpick.

Operation and Maintenance

Always read and follow the operator's manuals for all your spray equipment. They will tell you exactly how to use and care for it. After each use, rinse out the entire system. Remove and clean nozzles, nozzle screens, and strainers. Check for leaks in lines, valves, seals, and tank both after filling with water and during running.

Be alert for nozzle clogging and changes in nozzle patterns. If nozzles clog or other trouble occurs in the field, be careful not to contaminate yourself while correcting the problem. Shut off the sprayer and move it to the edge of the field before dismounting. Wear protective clothing while making repairs.

Store sprayers properly after use. But first, rinse and clean the system. Then fill tank almost full with clean water. Add a gallon or two of new light oil to the tank. Coat the system by pumping tank contents out through nozzles or handgun.

Filtering should be progressive, with the largest mesh screen in the suction line between the tank and the pump. Put a smaller mesh screen in the high pressure line between the pump and the pressure regulator. Put the finest mesh screen nearest the nozzles. Do not use a screen in the suction line of a centrifugal pump.

Clean strainers after each use. Replace them if you see deterioration. Strainers are the best defense against nozzles and pump wear and nozzle clogging. Use nozzle screens as large as nozzle sizes permit. Screen openings should be less than nozzle opening.

Hoses

Select synthetic rubber or plastic hoses that:

- have burst strength greater than the peak operating pressures,
- resist oil and solvents present in pesticides and
- are weather resistant.

Suction hoses should resist collapse. They should be larger than pressure hoses. All fittings on suction lines should be as large as or larger than the line itself.

Keep hoses from kinking or being rubbed. Rinse them often, inside and outside, to prolong life. Remove and store hoses during the off season, or at least store unit out of sun. Replace hoses at the first sign of surface deterioration.

Pressure Gauges

These serve as the monitor of your spraying job. They must be accurate and have only the range needed for your work. For example, a 0-60 psi gauge with 2 pound gradations would be enough for most low pressure sprayers.

Check frequently for accuracy against an accurate gauge. Do not use them under too much pressure. Keep glass faces clean and intact. Use gauge protectors to protect against corrosive pesticides and pressure surges.

Pressure Regulators

The pressure regulator must have a working range that is about the same as the range of pressure you plan to use.

Agitators

Make sure your sprayer has enough agitation. If it does not, your pesticide application rate may vary greatly as the tank is emptied. Bypass agitation may be good enough for solutions and emulsions. Use a jet agitator or mechanical agitator for wettable powders. Mechanical agitation is the surest way to get good agitation. It is expensive initially and is harder to maintain. Hand sprayers must be shaken frequently.

Control Valves

These valves should be large enough so as not to restrict flow. They should be easy for you to reach. On-off action should be quick and positive. You need to be able to cut off all flow or flow to any section of the spraying system. There are many different kinds of control valves. Be sure you know how to operate and maintain the ones on your equipment.

Nozzles

The nozzle helps control the rate and pattern of distribution. These things depend on:

- the nozzle design or types,
- its operating pressure,
- the size of the opening,
- its discharge angle, and
- its distance from the target.

There are five basic nozzle types. They are:

Solid stream - A type used in handguns to spray a distant target and for crack and crevice treatment in buildings. Also a type used in a nozzle body to apply pesticides in a narrow band or inject them into the soil.

Flat Fan - There are three types of flat fan nozzles:

The regular flat fan nozzle makes a narrow oval pattern with lighter edges. It is used for broadcast spraying. This pattern is designed to be used on a boom and to be overlapped 30-50 percent for even distribution.

The even flat fan nozzle makes a uniform pattern across its width. It is used for band spraying and for treating walls and other surfaces.

The flooding nozzle makes a wide-angle flat spray pattern. It works at lower pressures than the other flat fan nozzles. Its pattern is fairly uniform across its width. It is used for broadcast spraying.

Hollow cone - There are two types of hollow cone nozzles:

- the core and disk, and
- the whirl chamber.

The pattern is circular with tapered edges and little or no spray in the center. It is used for spraying foliage.

Full cone - This nozzle produces a circular pattern. The spray is well-distributed throughout the pattern. It is used for spraying foliage.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

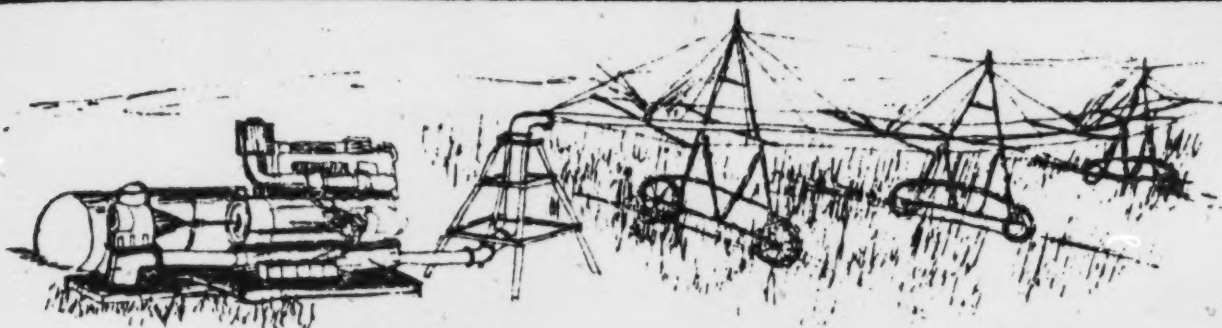
UNIT: CHEMICAL CONTROLS

MODULE: CALIBRATING THE SPRAYER

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. Briefly explain why it is important to properly calibrate a sprayer. 2. Complete sample problems on pesticide application, given information on spraying equipment and pesticide requirements. 3. Demonstrate ability to use the Nomograph. 4. Given a common pesticide and a low pressure spray rig, calibrate the sprayer and mix the material so that it can be applied according to the label recommendations.	Importance of proper calibration - efficiency: energy conservation - abide by government regulations - minimize environmental damage Calibration methods - gallons per minute (pumping rate) - acres per minute - gallons per minute - acres per tank - amount of chemical per tank Using the Nomograph - calibrate sprayer - determine amount of chemical needed - treat field	Read handout: <u>Using Pesticides Efficiently</u> (See previous module.) Read handout: <u>Basic Sprayer Calibration Procedures.</u> Have each student complete handout: <u>Sample Problems</u> Discuss transparency, <u>Sprayer Calibration Nomograph</u> Read handout: <u>Use of the Nomograph, Problems with Nomograph</u> Work sample: Go over answers in class. Field exercise: Using whatever spray equipment is available, sprayer will be calibrated and amount of chemical needed determined for various pests. Infested field will then be treated with recommended amounts of pesticide. Have students complete <u>Evaluation.</u>

FLORIDA COOPERATIVE EXTENSION SERVICE INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES

Department of Agricultural Engineering
University of Florida , Gainesville



Agricultural Engineering
Extension Report 74-15

November, 1975

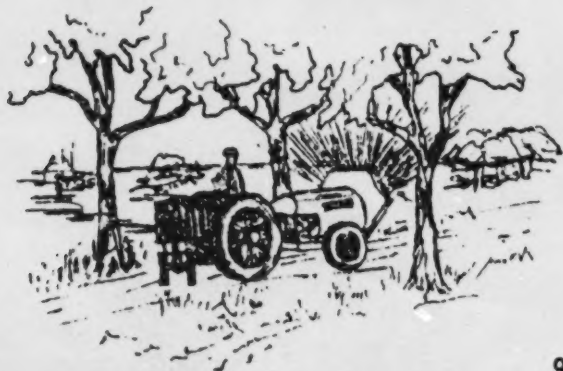
Basic Sprayer Calibration Procedures

Summary

Many pesticide applicators will be required to demonstrate their ability to apply pesticides in compliance with the directions on the label if they want to use materials listed in the Restricted Use Category by the Environmental Protection Agency.

Learning the calibration principles in this report should enable an applicator to calibrate any type of sprayer from a boom to an aircraft.

Richard P. Cromwell
Assistant Professor
Extension Agricultural Engineer



The primary reason a sprayer must be calibrated is to determine the gallons per acre (GPA) applied in order to know how many acres are covered by the sprayer's tank. Once the acres per tank are known, the applicator can mix in the correct amount of chemical which is recommended on the label usually in pounds or ounces per acre.

The gallons per acre (GPA) applied by a sprayer is the result of two factors: 1) The gallons per minute (GPM) output of the nozzles, and 2) The acres per minute covered by the sprayer. Knowing these two factors, the GPA can be determined from:

$$\text{Gal/Acre} = \frac{\text{Gal/min}}{\text{Acres/min}}$$

The GPA can be changed by changing the GPM, the acres per minute or both.

The GPM output of the nozzles and the acres per minute covered by the sprayer are usually independent of each other. The job of the applicator is essentially coordinating GPM and acres per minute to achieve the desired GPA.

How To Vary GPM?

GPM from the nozzles can be varied by: 1) Changing to a larger pump, 2) Varying the regulator opening, 3) Changing the size or number of nozzles. Essentially the two methods commonly used to change nozzle flow in order to calibrate a sprayer are to: 1) Change the size and number of nozzles for large changes and 2) Vary the regulator opening for small changes.

The pump output flows through either the opening in the nozzles or the opening in the regulator. Reducing the size of the regulator opening requires a greater pressure to force the pump output through the system. The increased pressure causes more flow from the nozzles. The greatest flow from the nozzles and the highest pressure occur when the regulator is completely closed off and all of the pump output passes through the nozzles. Enlarging the regulator opening results in a lower pressure and a lesser flow through the nozzles.

The flow changes practically induced by varying the regulator opening are usually small because the flow through an orifice varies as the square root of the pressure (The pressure must increase 4 times to double the flow), and it is often necessary to operate within a relatively narrow pressure range. As an example, the range of pressures recommended for spraying herbicides is 20

to 30 psi in order to control drift.

There are two commonly used methods for determining the GPM output of a sprayer. One is to determine the amount of liquid that must be poured back into the tank to refill it after a timed spraying. The other is to catch the flow from a few nozzles in a timed period, average the amount, and multiply by the number of nozzles on the boom. The tank refill method is the easiest and will be the method considered in this report. The timed spraying must be long enough to allow an accurate measurement of the amount needed to refill the tank. When possible, the sprayer should be in the exact location as it was when filled initially to reduce error.

Example 1: A sprayer is run for 3 minutes and it takes 18 gallons of liquid to bring the tank level back up to its initial level. What is the GPM?

$$\begin{aligned}\text{GPM} &= \frac{\text{Liquid needed to restore level (Gal)}}{\text{time interval (min)}} \\ &= \frac{18}{3} = 6\end{aligned}$$

How To Vary Acres Per Minute?

The sprayer swath width and forward speed determines the acres per minute covered by the unit. Varying the forward speed is the primary method used to vary the acres per minute, when calibrating a sprayer, because the swath width is usually fixed for a given sprayer. There are practical limitations to the amount of variation achievable from changing the forward speed because the applicator doesn't want to go too fast for safety reasons nor too slow because of low productivity.

The formula for calculating acres per minute is shown below:

$$\text{Acres/min} = \frac{\text{Swath width (ft)} \times \text{Speed (mph)} \times 88}{43,560}$$

where: 1) 88 is the ft/min equal to 1 mph

2) 43,560 is the square feet in an acre

This equation can also be written as:

$$\text{Acres/min} = \frac{\text{Swath width (ft)} \times \text{Speed (mph)}}{495}$$

An approximate equation which makes for much easier mathematics is:

$$\text{Acres/min} = \frac{2 \times \text{Swath width (ft)} \times \text{Speed (mph)}}{1000}$$

Example: A grower sprays with a row crop airblast sprayer that has an effective swath of 60'. How many acres per minute will he spray at a speed of 4 mph?

Using the exact equation:

$$\text{Acres/min} = \frac{\text{Swath width (ft)} \times \text{Speed (mph)}}{495} = \frac{60 \times 4}{495} = .485$$

Using the approximate equation:

$$\text{Acres/min} = \frac{2 \times 60 \times 4}{1000} = .480$$

Figure 1 in this report can be used to determine acres per minute sprayed when the swath and speed are known. The above example is plotted on the graph to illustrate its use.

Sprayer Calibration Problems Encountered By An Applicator

There are primarily two types of calibration problems that an applicator of pesticides might encounter. These types are outlined below:

Type 1: An applicator has a sprayer that is already nozzled and he wants to determine the gallons per acre being applied when traveling at a speed reasonable for the field conditions.

NOTE: This is the type of problem encountered when recalibrating to check for nozzle wear or when a farmer borrows another farmer's sprayer.

Type 2: An applicator wants to spray a crop with a specific amount of diluted spray per acre and he must nozzle the sprayer so that the specified amount is applied.

Examples of these different problems are given below:

Type 1 Example: A farmer wants to spray his pasture with a herbicide recommended at 1 pound of formulation per acre. His boom sprayer has a 20' boom and is equipped with flat fan nozzles used for broadcast spraying. The sprayer tank capacity is 100 gallons. The farmer would like to use 25 psi pressure to mini-

mize drift. Field conditions dictate a maximum speed of about 5 mph. Determine the following: GPA, acres covered by a tank of spray, and the amount of chemical to add to the tank.

Solution 1

This type of problem can be handled by the "Tenth of An Acre" method. The farmer would spray a measured course which would be equivalent to 1/10 of an acre. The length of the course would depend on the swath width. This method is outlined below:

$$\text{Square feet in } 1/10 \text{ acre} = 4356 \text{ ft.}^2$$

$$\begin{aligned} \text{Measured course length} &= \frac{\text{Square feet in } 1/10 \text{ acre}}{\text{Swath width}} = \frac{4356}{20} \\ &= 218 \text{ ft.} \end{aligned}$$

The farmer would spray the 218 feet long course, refill the tank with water and add a zero to the number of gallons that it took to refill. If it took 3 gallons to refill the tank, he would be applying 30 GPA.

This method is open to considerable error if the tank is large and the GPA relatively small because it would be difficult to determine the amount needed to refill the tank accurately. Spraying a bigger area would yield more reliable results. The only reason this method is used is that it eliminates most of the figuring required by other methods.

Solution 2

The farmer would write down the equation for GPA:

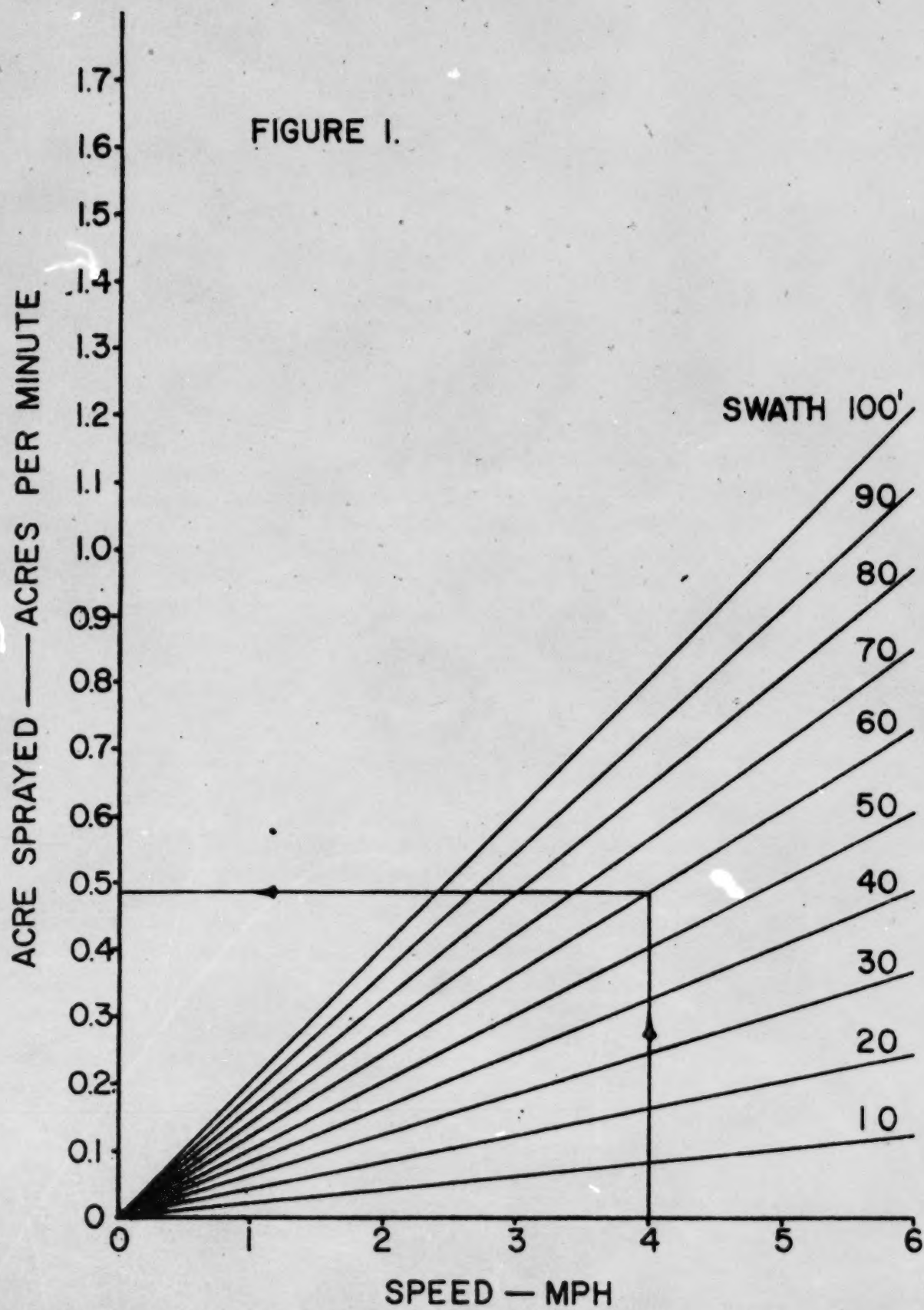
$$\text{GPA} = \frac{\text{GPM}}{\text{Acres/min.}}$$

Step 1: Determine GPM by running a timed refill test. Assume that a 2 minute test run required 12 gallons to restore the level.

$$\text{GPM} = \frac{\text{Liquid needed to restore level}}{\text{Time interval}} = \frac{12}{2} = 6$$

The flow test has to be run at the engine RPM which will be used while spraying. If the speed is being determined by a Gear - RPM Chart like on many tractors, the farmer might had better field check the combination if he isn't sure whether the tires are of the size associated with the chart.

FIGURE 1.



Step 2: Determine acres per minute since the swath width and speed are known.

$$\begin{aligned}\text{Acres/minute} &= \frac{2 \times \text{Swath width (ft)} \times \text{Speed (mph)}}{1000} \\ &= \frac{2 \times 20 \times 5}{1000} = 0.2\end{aligned}$$

Step 3: Determine GPA:

$$\text{GPA} = \frac{\text{GPM}}{\text{Acres/min}} = \frac{6}{0.2} = 30$$

Once the GPA is known the farmer is prepared to determine the acres per tank and the chemical per tank as shown below:

$$\text{Step 4: Acres/tank} = \frac{\text{Gallons/tank}}{\text{Gallons/acre}} = \frac{100}{30} = 3.33$$

Step 5: Chemical/tank = Acres/tank x Chemical/acre

$$\text{Chemical/tank} = 3.33 \times 1 = 3.33 \text{ lbs.}$$

*The chemical was recommended at 1 pound of formulation per acre.

If the recommendation were given as 1 pound of active ingredient per acre, the amount of the formulation to add would have to be determined and would depend on the % AI in the formulation. Assuming a 50% wettable powder was being used, it would require 2 pounds of formulation in order to be adding 1 pound of active ingredient. The farmer in the problem above would add 6.66 pounds of formulation.

Type 2 Example: A farmer has an air blast sprayer that has a 12 GPM pump, a 100 gallon tank, and has an effective swath of 40 feet. The sprayer's manifold can accommodate 12 nozzles. The farmer wants to apply a fungicide recommended at 1 pound of formulation in about 20 gallons of spray mix per acre. Field conditions will allow a tractor speed of about 6 mph. Determine the following: 1) Can the sprayer apply this application with its 12 GPM capacity, 2) What nozzles should be used if about 150 psi pressure is used, and 3) Amount of formulation to add to the tank.

Step 1: Write down the GPA equation which is applicable for any type of calibration problem.

$$\text{GPA} = \frac{\text{GPM}}{\text{Acres/min.}}$$

In this type of problem the GPA was given as 20 so the GPM needed in order to be applying 20 GPA can be determined if the acres per minute are known.

Step 2: Determine acres per minute since the swath and speed are known.

$$\text{Acres/min} = \frac{2 \times 40 \times 6}{1000} = .480$$

Step 3: Determine the GPM required by rearranging the equation in Step 1.

$$\text{GPM} = \text{GPA} \times \text{Acres/min} = 20 \times .48 = 9.6$$

The sprayers pump would have to deliver 9.6 GPM to apply 20 GPA under the specified conditions. The pump is rated at 12 GPM so the desired application is possible.

Step 4: Pick the proper nozzle from a manufacturers nozzle performance catalog in the following manner.

$$\text{Required GPM/nozzle} = \frac{9.6}{12} = 0.8$$

Figure 2 of this report is some performance data for hollow cone nozzles which are widely used on air-blast sprayers. Look for a nozzle which delivers 0.8 GPM at about 150 psi pressure. The nearest nozzle is the D5-45 combination which delivers 0.86 GPM. Using this nozzle at 150 psi would mean the GPA would actually be greater than 20.

$$\text{GPM from all twelve nozzles} = 12 \times 0.86 = 10.3$$

Since 10.3 is still less than the pump capacity, it is possible to use the D5-45 combination.

Step 5: Reevaluate GPA for the 10.3 GPM.

$$\text{GPA} = \frac{\text{GPM}}{\text{Acres/min}} = \frac{10.3}{.48} = 21.5$$

Step 6: Determine acres per tank and the formulation to add to each tank.

$$\text{Acres/tank} = \frac{\text{Gallons/tank}}{\text{Gallons/acre}} = \frac{100}{21.5} = 4.65$$

$$\begin{aligned} \text{Chemical Formulation/tank} &= \text{Amount/acre} \times \text{acres/tank} \\ &= 1 \times 4.65 = 4.65 \text{ pounds} \end{aligned}$$

HANDOUT

SAMPLE PROBLEMS

Gallons Per Minute

(pumping Rate)

$$\text{GPM} = \frac{\text{Liquid needed to refill tank (gal)}}{\text{Time interval (min)}}$$

1. 10 gallons of water are needed to refill a tank after 5 minutes of pumping. What is the pumping rate in GPM?
2. After pumping for 10 minutes, it takes 10 gallons to refill the tank. What is the pumping rate in GPM?

Acres Per Minute

To determine acres/min

$$\text{Acres. min} = \frac{\text{Swath width X speed (mph)}}{495}$$

3. Using a sprayer with a 20 foot boom, you plan to apply a herbicide while moving at 4 mph. How many acres will be covered in one minute?
4. Traveling at 5 mph and using a boomless sprayer with a swath width of 10 feet, how many acres per minute will be covered?

Gallons Per Acre

5. In problem #1 above you determined gallons per minute and in problem #3 above you determined the acres covered per minute. Using this information, determine the gallons per acre which would be applied.
6. In problem #2 above you calculated gallons per minute and in problem #4 above you determined the acres covered per minute, using this information, determine the gallons per acre which would be applied.

Acres Per Tank

7. Your spray rig has been found to apply 12.5 gallons per acre at the desired speed. The tank holds 100 gallons of liquid. How many acres will one tank cover?
8. Using a 50 gallon tank, you plan to spray at a rate of 10 gallons/acre. How many tanks will it take to cover 100 acres?

Chemicals Per Tank

Sample Problems

9. A herbicide label recommends application at 1-1/2 pints/acre. Your spray rig is calibrated to spray 8 acres per tank. How many pints of the liquid should be added to each tank?
10. The label on a wettable powder says that the powder is 20% active ingredient. Your county agent recommends that you apply one-half pound of ingredient/acre. How many pounds of powder should you add your tank if you cover 5 acres/tank?

SOLUTIONS TO SAMPLE PROBLEMS

Gallons Per Minute

1. $\text{GPM} = \frac{10 \text{ gal. (to refill tank)}}{5 \text{ minutes}} = 2$

Pumping rate is 2 gallons/minute

2. $\text{GPM} = \frac{10 \text{ gal.}}{10 \text{ min.}} = 1$

Pumping rate is 1 gallon/minute

Acres Per Minute

3. $\frac{20\text{ft.} \times 4\text{mph}}{495} = \frac{80}{495} = .16$

4. $\frac{10\text{ft.} \times 5\text{mph}}{495} = \frac{50}{495} = .10$

Gallons Per Acre

5. $\text{GPA} = \frac{2 \text{ GPM}}{.16 \text{ acre/min}} = 12.5$

$\text{GPA} = 12.5$

6. $\text{GPA} = \frac{1 \text{ GPM}}{.10 \text{ acre/min}} = 10$

$\text{GPA} = 10$

Acres Per Tank

7. $\text{acres/tank} = \frac{100 \text{ gal. tank}}{12.5 \text{ gal/acre}} = 8$

8 acres per tank

8. $\text{acres/tank} = \frac{50 \text{ gal.}}{10 \text{ gal/acre}} = 5$

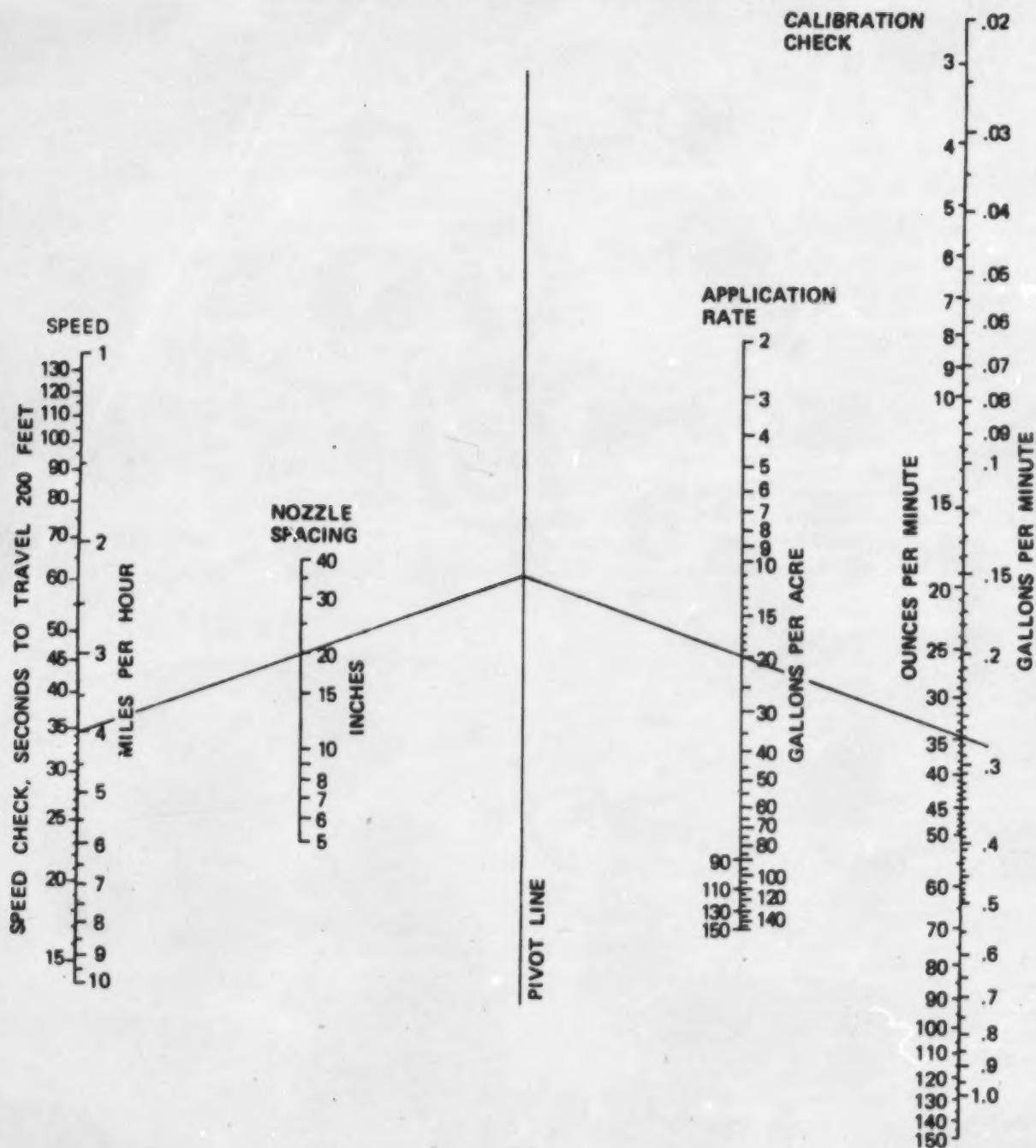
$\frac{100 \text{ acres}}{5 \text{ acres/tank}} = \underline{25 \text{ tanks}}$

9. $\text{chemicals/tank} = 8 \text{ acres/tank} \times 1.5 \text{ pints/acre} = 12 \text{ pints/tank}$
 $12 \text{ pints/tank} = \underline{1\text{-}1/2 \text{ gal.}}$

10. $\text{chemicals/tank} = 5 \text{ acres/tank} \times .5 \text{ pounds active ingredient/acre} = 2.5$
pounds of active ingredients per tank. Powder is 20% active ingredient (AI)

$\frac{2.5 \text{ pounds AI}}{.20 (20\%)} = \underline{12.5 \text{ pounds of powder}}$

Sprayer Calibration Nomograph



HANDOUT

USE OF THE NOMOGRAPH

By using a Nomograph, you can determine the correct speed to travel, nozzle spacing, application rate (GPA) or calibration in ounces or gallons per minute if three of these are known.

Example:

The sprayer ground speed is 4 mph, the nozzle spacing is 20 inches, and desired application rate is 20 gallons per acre. At what rate should the liquid flow from each nozzle.

Solution:

Use a straight edge, draw a line from 4 mph through 20 inches on nozzle spacing line. Mark the point where line meets pivot line. Now draw a line from that point through 20 gallons/acre on application rate line and locate the point where it intercepts the calibration check line. This point is at 35 ounces/minute or .27 gallon /minute.

This tells us that we should have a flow rate of 35 ounces/minute or .27 gallon /minute from each nozzle. We can then select the proper size nozzle tip.

Another example:

We plan to travel five miles per hour and we know that the nozzle spacings are 25 inches apart and that run eight ounces a minute. Using the Nomograph we find that our application rate will be 3.5 gallons per acre. What could be done to increase this rate to 10 gallons per acre?

PROBLEMS WITH NOMOGRAPH

Use the nomograph provided on the following page to calculate the problems below:

1. A broadcast sprayer has a 20 inch nozzle spacing. A check of the nozzles shows each one puts out 28 ounces per minute. How fast would you have to drive to apply 15 gallons per acre?

2. Rows are 40 inches apart. You want to spray a 14 inch band at 5 miles per hour and with an equivalent broadcast rate of 25 gallons per acre. How many ounces per minute would be applied?

3. You want to spray a broadcast rate of 25 gallons per acre at a speed of 3.5 miles per hour. The nozzles are spaced 20 inches apart on the boom. What should be the flow rate for each nozzle?

EVALUATION

1. List three (3) ways that pesticides contribute directly or indirectly to overall energy use.

2. List four (4) precautions that should be taken when applying pesticides, to assure the effectiveness of the chemical with as little waste as possible.

3. For a series of examples of pesticides labels, write
 - a. Type of pesticide

 - b. Formulation

 - c. Storage and disposal precautions

 - d. Toxicity category

 - e. Amount of active ingredient

 - f. Application restrictions

 - g. Crops and pests it can be used on

4. List and briefly explain three (3) reasons why it is important to properly calibrate a sprayer.
5. A sprayer is run for 4 minutes and it takes 12 gallons to refill the tank. What is the sprayers output in gallons per minute (GPM)?
6. If a grower uses a sprayer with a swath width of 30 ft and travels at a speed of 4 mph, how many acres per minute (APM) will be treated?
7. If a spray rig puts out 6 gallons per minute (GPM) and covers .30 acres per minute, how many gallons per acre (GPA) will be applied?
8. A sprayer is found to apply five (5) gallons per acre at the desired speed. The tank holds 100 gallons. How many acres will one tank cover?
9. A pesticide label recommends application of 2 pints per acre. If a spray rig is calibrated to spray 8 acres per tank how many pints of the chemical should be added to the tank?
10. Given the following information, use a nomograph to determine proper nozzle spacing.
 - speed - 3 mph
 - application rate - 15 GPA
 - calibration - .15 GPM

LOW ENERGY TECHNOLOGY
CROP PROTECTION FOR INTEGRATED PEST MANAGEMENT

UNIT: PRACTICAL APPLICATIONS

MODULE: INSECT CONTROL

STUDENT PERFORMANCE OBJECTIVES

CONTENT

TEACHING-LEARNING ACTIVITIES

The student will be able to:

1. List three methods of controlling insect pests and write one way that each uses or saves energy.

Insect Control Methods:

- cultural
- scouting & monitoring
- natural and biological
- resistant varieties
- chemical (insecticides)

Read handout: Saving Energy In Insect Control - Integrated Methods.

Assignment: Each student is assigned a crop commonly grown in the area. Using the library and local farmers as resources the student will find the names of insects affecting the crop and what control methods are available for each insect. Information will be written on Pest Management Sheet. Discuss findings in class.

HANDOUT

SAVING ENERGY IN INSECT CONTROL

INTEGRATED METHODS

By using a variety of prevention and control methods, farmers can reduce insecticide use and save energy in insect management.

1. Cultural control methods - Many cultural practices can help save energy in pest management. Some of these are crop rotations, sanitation, trap crops, fertility and water management and timely planting dates. These methods are meant to prevent insects from becoming a problem. In this way they reduce insecticide use and save energy.
2. Scouting and Monitoring - By carefully monitoring insect populations, farmers will know when treatment is needed and how much is needed. This assures good control of insect pests and usually saves on insecticides and energy use.
3. Natural and Biological Control - Growers can save energy by being aware of insects' natural enemies and encouraging these beneficials in crop fields. Sometimes it is possible to release biological control organisms into a crop field.
4. Resistant Varieties - By using crop varieties that are less desirable to insects or less sensitive to insect damage, farmers can save insecticides and energy. Insect resistant or tolerant varieties are available for many crops.
5. Insecticides - This is the control method that uses the most energy. Chemical insecticides are still needed however, to protect the farmers' investment in a crop. To save energy, growers should use insecticides only when needed. Use the correct amount and apply it properly.

PEST MANAGEMENT SHEET

Crop	Insects Affecting It	Resistant Varieties	Cultural Control Methods	Biological Control Organisms	Chemical Insecticides (Name)
	1.				
	2.				
	3.				
	4.				
	5.				
	6.				
	7.				
	8.				

110

141

142

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: PRACTICAL APPLICATIONS

MODULE: NEMATODE CONTROL IN
PEANUTS-SOYBEANS

STUDENT PERFORMANCE OBJECTIVES

CONTENT

TEACHING-LEARNING ACTIVITIES

The student will be able to:

1. List five methods of control that can be used together or separately to control nematodes in peanuts and/or soybeans.

Nematode control methods:

By using a combination of methods, a grower can reduce his use of chemical nematicides and save energy.

- resistant varieties
- crop Rotation
- sanitation
- tillage
- fumigation

Read handout: Peanut Nematode Management.

2. Write a description, in 200 words or less, of each of three control methods that can be integrated for nematode control in soybeans and will save energy by reducing the amount of chemical treatment needed.

Nematode control in Soybeans

- crop rotation
- early destruction of crop and weed nematodes
- variety resistance
- Nematicides
- sanitation/quarantine

Read handout: Soybean Nematode-Resistant Varieties and Nematicides.

Find pictures in magazines of nematodes affected crop plants, ads for chemical nematicides, crop varieties, application equipment, etc.

HANDOUT

PEANUT NEMATODE MANAGEMENT

A good peanut grower follows a multi-point program of land management which helps minimize long-term increase of nematodes and other soil-borne problems, and helps his nematicide(s) do the best job possible. No nematicides can overcome unreasonable high nematode populations and poor land preparation. The following steps are important parts of a complete nematode management program.

1. Crop rotation: Peanuts should follow poor hosts of root-knot nematodes, such as small grain or pasture grasses. Avoid following soybeans or vegetables. Field corn is only fair for reducing root-knot nematode populations, but is better than continuous peanuts or following soybeans or vegetables. Long rotations of three or more years are much better than one or two year rotations. Rotations are of little value for reduction of peanut lesion nematode numbers, because it lives on so many different plants.

2. Destroy roots of the preceding crop as promptly as possible. Shredding crop residues by disking several inches deep removes the food source of nematodes that could otherwise continue building up in numbers. This initiates decomposition of plant roots, so that plant nematodes in the field are exposed to natural control agents in the soil over the winter, and to your nematicides in the spring.

3. A winter cover crop of small grain can help prevent growth of weed hosts of peanut nematode pests and will help protect the soil from erosion during the winter.

4. Turn the land with a moldboard plow three to four weeks before fumigation. This buries surface litter, thus reducing some fungus diseases, and encourages breakdown of live plant roots which could protect nematodes from a nematicide.

5. Fumigation before or at planting with one of the products listed in Table 2 is recommended where peanut root-knot nematode is a problem. Both ethylene dibromide (EDB) and dichloropropene (1,3-D) effectively control root-knot and other nematodes when used as directed, two - three weeks before planting. EDB and 1,3-D are highly volatile (become gases and escape from the soil very easily), so proper soil preparation and effective sealing of the injection slits are critical to use them effectively. They should be placed eight inches deep.

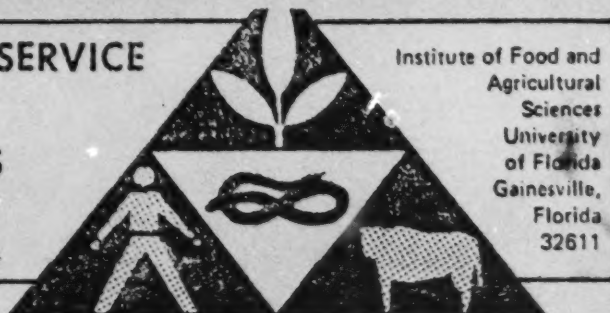
The peanut root-knot nematode (*Meloidogyne arenaria*) is the most serious nematode pest of peanuts in Florida. It attacks the roots throughout the season, stunting the plants and reducing yields. Direct injury to pods reduces quality. Control of this nematode in sandy soils has often increased yields by more than 1000 lb/acre.

Lesion nematodes (*Pratylenchus brachyurus*) reduce the yield by injuring pegs so badly that peanuts break off from the plants when they are plowed up at harvest. This often results in losses of several hundred pounds of peanuts per acre. The pod lesions these nematodes cause contribute directly to pod-rot.

FLORIDA COOPERATIVE EXTENSION SERVICE

Plant Protection Pointers

DEPARTMENT OF ENTOMOLOGY AND NEMATOLOGY



Extension Nematology Report #13

Draft May, 1981

SOYBEAN NEMATODE-RESISTANT VARIETIES AND NEMATICIDES*

Effective management of nematodes in soybeans requires a combination of several methods: crop rotation, early destruction of crop and weed residues, varietal resistance, and nematicides. In addition, sanitation/quarantine efforts should be made to avoid introducing new nematodes (such as soybean cyst nematode or an additional species of root-knot nematode) to your land.

It is important to identify the specific kinds of nematodes in each soybean field so you can select the best rotation, resistant variety, and nematicide (if needed) for each situation. If you do not know which nematodes are in a field from its history and crop symptoms, laboratory analysis of soil samples can help provide that information. Nematode Sample Kits containing materials and instructions for collecting and submitting samples to the Florida Nematode Assay Laboratory are available at county extension offices.

Resistant varieties are often the most effective tool against soybean cyst, root-knot, and reniform nematodes. Table 1 lists varieties which have effective levels of resistance against one or more important nematodes. Each will perform satisfactorily in some parts of Florida, but few are well adapted to all areas where soybeans are grown.

The resistance against soybean cyst nematode in the variety 'Centennial' is only effective against Race 3 of this nematode. Other races (specialized populations), to which 'Centennial' and related varieties are not resistant, are found in some states. This makes it especially important to avoid bringing seed or machinery used in other soybean areas into Florida unless certified to be free of soybean cyst nematodes.

In many states, repeated use of Race 3 resistant soybeans in the same field has caused other races of the nematode to take over the field. There seems to be a little bit of the capacity to develop resistance-breaking races in most populations of Race 3 of soybean cyst nematodes. When only Race 3-resistant soybeans are grown in the field, the nematodes with the resistance-breaking capability are able to feed and reproduce while most of the population cannot. After several years, the new race takes over. Although 'Bedford' is resistant

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to Race 4, its repeated use has caused the development of new races to which no variety is resistant. The best way to reverse or prevent development of the new races seems to be to occasionally grow a Race 3-susceptible variety in the cropping sequence. For instance, in a field known to have soybean cyst (Race 3) and southern root-knot nematode (*M. incognita*), a good 4-year cropping sequence might be 'Centennial' soybeans, corn, 'Hutton' soybeans, then repeat the cycle.

The resistance against soybean cyst nematode Race 3 in 'Centennial' seems to be very strong. Nematicides have rarely increased yields of 'Centennial' enough to pay for the treatment in IFAS tests. Nematicides are not generally recommended for soybean cyst nematode control in Florida when an adequate resistant variety is used.

Resistance against root-knot nematodes is not so complete as that for cyst. Root-knot nematode-resistant varieties will produce better yields than susceptible ones in the presence of the species to which they have resistance, but the yield may be further increased by use of a fumigant nematicide. Varieties shown to be "moderately susceptible" in Table 1 almost always need the help of a nematicide to produce well in the presence of the specified nematode.

Table 1. Nematode-resistant soybean varieties recommended for Florida

Variety	Maturity Group	Soybean Cyst Race 3	Nematode Resistance*			
			Root-knot nematode (<i>Meloidogyne</i>) species <i>M. incognita</i> "Southern"	<i>M. arenaria</i> "peanut"	<i>M. javanica</i> "Javanese"	Reniform
Bedford	V	R**	M	M	--	--
Centennial	VI	R	R	S	M	R
Bragg	VII	S	R	M	M	S
Braxton	VII	S	R	R	M	S
Cobb	VIII	S	R	S	S	S
Hutton	VIII	S	R	S	M	S

* R = Resistant, S = Susceptible, M = Moderately susceptible.

** Bedford is also resistant to Race 4 of soybean cyst nematode.

Nematicides (Table 2) are recommended where resistance cannot adequately control specific problems identified in a field. Soilbrom 90® (fumigant containing ethylene dibromide or EDB) has been the most effective soybean nematicide in tests in the southeast during the last 3 years. It may be applied before or at planting through 1 chisel/row, slightly offset from the seed drill. Rate for most situations is 1.0-1.5 gal/acre for 36-inch row spacing (8.8-13.2 fl. oz./1000 ft. of row, regardless of chisel spacing). For control of soybean cyst nematode and in soils with 5% or higher organic matter content, use up to 2 gal/acre (17.6 fl. oz./chisel/1000 ft. of row).

D-D and Telone II are also very effective for control of root-knot, cyst, and other nematodes, but must be used 2-3 weeks before planting to avoid injury to soybeans.

The granular nematicide which has been most consistently effective for soybean nematode control in tests in the southeastern United States has been Temik 15G. This product may be used at planting time at rates of 10-20 lbs. per acre (11-15 oz. per 1000 ft. of row), applied in a 6 to 12 inch band, covered or incorporated into the soil to a depth of 2-4 inches. While rarely equal to fumigants for root-knot nematode control, it has generally provided control well above the cost of the treatment, and may in many cases prove convenient and satisfactory. The higher rates should be used where there are severe problems with root-knot or cyst nematodes. Most research in the southeast has had the most favorable responses to application in a 6-8 inch wide band, centered over the seed row.

Nemacur 15G is also registered for application in a band pattern with shallow incorporation. Use 13-24 lbs. per acre, based on 36" row spacing (14.7-26.7 oz. per 1000 ft. of row for any row spacing). Its nematicidal effectiveness is similar to that of Temik, but it has much less insecticidal activity.

Metribuzin herbicides (Sencor and Lexone) occasionally interact with soil-applied organophosphate nematicide-insecticides to cause moderate to serious stunting of soybeans. Of the organophosphate products registered for use on soybeans in Florida, Nemacur is the least likely to suffer this phytotoxic interaction, but mild cases have occasionally been observed. Conditions which enhance or reduce this effect are not understood, so it is impossible to predict the potential for such a problem in any given year or any given field. Thus far, this kind of phytotoxic effect has not been reported in the field in Florida where carbamate products such as Temik have been used with soybeans, and there is no evidence to indicate that such an effect can take place with the soil fumigants such as Soilbrom. Growers should keep this potential problem in mind when selecting soybean nematicides.

Table 2. Nematicides registered for use on soybeans in Florida. Soilbrom 90, D-D and Telone II are recommended for control of moderate or higher populations of root-knot nematodes. All should adequately control sting nematodes. Nematicides are not recommended for control of soybean cyst nematode, because they do not consistently increase yields of resistant varieties sufficiently to repay the cost of the treatment.

Product	Rate/1000 ft of row for any row spacing	Approximate Rate/acre 36-inch (90 cm) rows	Approximate rate/acre 30-inch (75 cm) rows	Comments
Soil Fumigants: apply through 1 chisel per row				
Soilbrom 90	8.8-13.2 fl oz	1.0-1.5 gal	1.2-1.8 gal	Apply before or at planting
D-D	79-97 fl oz	9.0-11.0 gal	10.8-13.2 gal	Must be applied 2-3 weeks before planting
Telone II	46-62 fl oz	5.2-7.0 gal	6.3-8.4 gal	Must be applied 2-3 weeks before planting
Non-Fumigants; apply in a narrow (6-10 inches wide) band, lightly incorporated or covered at time of planting.				
**Dasanit 15G	13.3 oz	12 lb	14.5 lb	
**Mocap 10G	22-33 oz	20-30 lb	24-36 lb	
**Nemacur 15G	14.7-26.7 oz	13-24 lb	16-29 lb	
Temik 15G	11-15 oz	10-13 lb	12-16 lb	

* Caution: Dasanit, Mocap, or Nemacur may have a serious interaction with metribuzin herbicides (Sencor, Lexone); see text. Do not apply Mocap in the seed furrow. It could cause serious injury to the seed.

**To convert rates to metric equivalents, multiply:

fl oz/1000 ft x 9.7 = cc/100m
 oz (avd.)/1000 ft x 9.3 = g/100m
 gal/acre x 9.35 = liter/ha
 qt/acre x 2.34 = liter/ha
 lb/acre x 1.12 = kg/ha

Trade and brand names are used only for information. The Florida Cooperative Extension Service does not guarantee any product mentioned, nor imply approval of any product to the exclusion of others which are equally suitable and may be legally used for the purpose(s) specified.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: PRACTICAL APPLICATIONS

MODULE: DISEASE CONTROL

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: 1. List three methods for control of crop diseases and write one way that each uses or saves energy.	Disease Control Methods - cultural - resistant varieties - regulatory - monitoring - chemical (fungicides)	Read handout: <u>Integrated Methods for Low Energy Disease Control</u>. Assignment: Each student will be given one of the five control methods listed. The student will then research and report on one or more crop disease in the area controlled by that method.

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HANDOUT

INTEGRATED METHODS FOR LOW ENERGY DISEASE CONTROL

By using several methods for prevention and control of crop diseases, farmers can save energy by reducing fungicide use.

Cultural control There are many preventative, cultural methods for reducing crop disease problems. These include sanitation, crop rotation and water management. By preventing the buildup of disease organisms, these cultural practices save energy in disease control.

Resistant varieties Whenever possible, growers should plant crop varieties that are bred to resist problem diseases. Planting these varieties will reduce the need for fungicides and save energy.

Regulatory control Government regulations for inspection and quarantine, and restrictions on the transporting of plant material can help prevent introduction and spreading of crop disease. These regulations save the energy that would be needed to control these diseases once they are established.

Monitoring By observing the daily temperature, humidity, rainfall, and wind speed; and by measuring the amount of spores in the air, scientists can forecast the occurrence of certain fungus diseases. This allows the farmer to hold off with fungicide applications until they are needed. By eliminating "preventative" sprayings, disease monitoring can save energy.

Chemical control Sometimes chemical fungicides are the only way to protect a crop from harmful disease. To conserve energy, farmers should use these chemicals only when needed. They should be applied at the rates recommended on the label, using properly functioning equipment and under the right weather conditions.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: PRACTICAL APPLICATIONS

MODULE: WEED CONTROL

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to:		
1. List and explain two ways that weeds compete with crops for energy.	Weeds compete with crops for energy - sunlight - solar energy - nutrients - fertilizer energy - moisture - irrigation energy	Read handout: <u>Weeds and Energy</u> .
2. List and explain five ways commonly being used to control weeds.	Weed Control Methods - chemical - high energy - cultivation - high energy - row spacing - competitive variety - fertility and water management - biological	Read handout: <u>Weed Control and Energy</u> Show slide tape presentation <u>Weed Control</u> ST 0120 (IFAS Editorial).
3. List and explain three ways to save energy in weed control.	Ways to save energy in weed control - reduce herbicide use by scouting and timely spraying - reduce number of cultivations - closer row spacing - competitive varieties	Read handout: <u>Ways to Save Energy in Weed Control</u> . Field activity - Take class into crop fields to find and identify weeds, - discuss - competition by weeds - control methods being used - available methods that could save energy

HANDOUT

WEEDS AND ENERGY

Any crop uses energy to grow. Weeds compete for that energy. A weedy field is much less energy efficient than a clean field. This is because so much of the energy input is being used by the weeds rather than the crop.

There are several ways that weeds compete with crops for energy.

1. Fertilizer energy - weeds compete for nutrients. The energy used to produce and apply fertilizer is wasted if the nutrients are taken up by weeds. In this way, weeds compete for fertilizer energy.
2. Solar energy - weeds and crop plants need sunlight to grow. Weeds in a crop field often grow large enough to shade out the crop plants. The crop plants that are shaded out will not grow as well. Yield will be reduced. In this way, weeds compete for energy from the sun.
3. Irrigation energy - Water often needs to be pumped into a field to provide moisture for crops. Weeds also need water to grow. The amount of energy used to move water from its source to a crop field is quite large. If weeds are taking up moisture from the soil, the water and the energy used to pump it are wasted. In this way, weeds compete for irrigation energy.

HANDOUT

WEED CONTROL AND ENERGY

Weeds compete for energy in crop production. They take up nutrients, sunlight and moisture that could be used by crop plants. Weed control is important for energy conservation.

Weed control also uses energy. To be the most energy efficient in agricultural production, farmers should use weed control methods that use the least energy.

Here are some of the methods now being used to control weeds.

1. Chemical control - herbicides require large amounts of energy to produce and apply. Chemical control is however the most effective and widely used method.
2. Cultivation - cultivating between the rows to kill weeds is effective and often used. It also requires a large amount of fuel energy.
3. Row spacing - in some crops planting narrow rows can help to reduce competition from weeds. This is a low energy method.
4. Competitive varieties - By planting hardy, well adapted crop varieties, farmers can reduce weed problems. Crop plants that are best adapted to the conditions will grow quickly and crowd out weeds. This is a low energy method.
5. Fertility and water management - proper placement, timing and amount of fertilizer and water supplied to a crop can help to control weeds. Growers should try to make nutrients and water available to the crop plants but not to the weeds.
6. Natural and Biological control - Weeds have natural enemies. Many insects feed on weeds. Weed plants are often infected by disease. Growers can utilize these natural controls to prevent weed problems. In some cases, insects or diseases can be released by farmers to kill weeds. This is called biological control. This is a very low energy method.

HANDOUT

WAYS TO SAVE ENERGY IN WEED CONTROL

1. The best way to save energy in weed control is to reduce the amount of herbicide used and tractor fuel for spraying and cultivation.
 - a. Timely spraying - most weeds are killed easiest when they are small. By spraying them early, farmers can get best control while using less chemical.
 - b. Scouting - farmers should carefully monitor fields for weeds. By knowing what kinds of weeds are there, how many and how big they are, energy can be saved in controlling them.
 - c. Close row spacing - some crops can be spaced closely to crowd out weeds. Growers should consult other growers or county extension agents for the best row spacing.
 - d. Best varieties - farmers can save large amounts of energy in weed control by planting the crop varieties best adapted to the local conditions. Modern, high producing cultivars will grow quickly and compete with weeds. The weeds will not have a chance to establish themselves and herbicide use is reduced.
 - e. Fertility and water management - fertilization and irrigation should be done at the right time, when the crop needs it. This will give the plants a competitive advantage over weeds. Excess fertilizer and water will benefit weeds. Careful management can help save energy in weed control.
 - f. Natural and Biological control - by utilizing weeds' natural enemies whenever possible, growers can reduce herbicide use and save energy.

LOW ENERGY TECHNOLOGY
CROP PROTECTION WITH INTEGRATED PEST MANAGEMENT

UNIT: PRACTICAL APPLICATIONS

MODULE: UNIT SUMMARY

STUDENT PERFORMANCE OBJECTIVES	CONTENT	TEACHING-LEARNING ACTIVITIES
The student will be able to: Given a list of types of crops and livestock, name one class of pest affecting each and two control methods that can be used to save energy in the management of that pest.	Integrated Pest Management Methods for - field crops - vegetables - pastures - citrus - turf - foliage - stored grains - livestock - poultry - forestry	Read handout: <u>IPM Tactics</u>. Use information from handout and previous lessons to fill out IPM chart. Have students complete <u>Evaluation</u>.

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HANDOUT

I.P.M. TACTICS

Energy use in pest management can be reduced by using a variety of control tactics.

Field Crops

A. Insects

1. Cultural controls
 - a. crop rotation
 - b. planting dates
 - c. sanitation
 - d. trap crops
2. Natural and biological control
 - a. predators
 - b. parasites
 - c. pathogens
3. Resistant varieties
4. Scouting and monitoring
 - a. pests
 - b. beneficials
5. Regulatory control
 - a. inspection
 - b. quarantine

B. Diseases

1. Cultural controls
 - a. crop rotations
 - b. sanitation
 - c. water management
2. Resistant varieties
3. Scouting and monitoring
 - a. weather conditions
 - b. spore traps
4. Regulatory control
 - a. inspection
 - b. quarantine
 - c. seed certification

C. Weeds

1. Cultural controls
 - a. cultivation
 - b. sanitation
 - c. row spacing
 - d. water management
 - e. fertility management
2. Well adapted varieties
3. Scouting and monitoring
4. Regulatory control
 - a. inspection
 - b. seed certification

D. Nematodes

1. Cultural controls
 - a. crop rotation
 - b. sanitation
 - c. water management
 - d. subsoiling
2. Resistant varieties
3. Scouting and monitoring
 - a. nematode symptoms
 - b. soil sampling
4. Regulatory control
 - a. inspection
 - b. quarantine
 - c. seed certification

Vegetables

A. Insects

1. Cultural controls
 - a. crop rotation
 - b. sanitation
 - c. planting dates
 - d. trap crops
2. Natural and biological control
 - a. predators
 - b. parasites
 - c. pathogens
3. Resistant varieties
4. Scouting and monitoring
 - a. pests
 - b. beneficials
5. Regulatory control
 - a. inspection
 - b. quarantine

B. Diseases

1. Cultural controls
 - a. crop rotations
 - b. sanitation
 - c. water management
2. Resistant varieties
3. Scouting and monitoring
 - a. weather conditions
 - b. spore traps
4. Regulatory control
 - a. inspection
 - b. quarantine
 - c. seed certification

C. Weeds

1. Cultural controls
 - a. cultivation
 - b. sanitation
 - c. row spacing
 - d. water management
 - e. fertility management
 - f. mulches

2. Scouting and monitoring
3. Regulatory controls
 - a. inspection
 - b. seed certification

D. Nematodes

1. Cultural control
 - a. crop rotation
 - b. sanitation
 - c. water management
2. Resistant varieties
3. Scouting and monitoring
 - a. nematode symptoms
 - g. soil sampling
4. Regulatory control

Pastures

A. Insects

1. Cultural controls
 - a. rotations
 - b. fertility management
 - c. sanitation
2. Natural and biological control
 - a. predators
 - b. parasites
 - c. pathogens
3. Resistant varieties
4. Scouting and monitoring
5. Regulatory control
 - a. seed certification
 - b. inspection
 - c. quarantine

B. Diseases

1. Cultural controls
 - a. water management
 - b. sanitation
 - c. rotation

2. Resistant varieties
3. Scouting and monitoring
4. Regulatory control
 - a. seed certification
 - b. quarantine
 - c. inspection

C. Weeds

1. Cultural controls
 - a. fertility management
 - b. seeding rates
2. Natural and biological controls
3. Well adapted varieties
4. Scouting and monitoring
5. Regulatory control
 - a. seed certification

Citrus

A. Insects

1. Natural and biological control
 - a. predators
 - b. parasites
 - c. pathogens
2. Resistant varieties
3. Scouting and monitoring
4. Regulatory control
 - a. quarantine
 - b. inspection
 - c. certification of rootstock

B. Diseases

1. Resistant varieties
2. Scouting and monitoring

- 3. Regulatory control
 - a. quarantine
 - b. inspection
 - c. rootstock certification
- C. Weeds
 - 1. Cultural methods
 - a. cultivation
 - b. water management
 - 2. Scouting and monitoring
- D. Nematodes
 - 1. Scouting and monitoring
 - 2. Regulatory control
 - a. quarantine
 - b. inspection
 - c. certification of rootstock

Turf

- A. Insects
 - 1. Cultural methods
 - a. mowing height
 - b. fertility management
 - 2. Natural and biological control
 - 3. Resistant varieties
 - 4. Scouting and monitoring
- B. Diseases
 - 1. Cultural methods
 - a. mowing height
 - b. fertility and water management
 - 2. Resistant varieties
 - 3. Scouting and monitoring
- C. Weeds
 - 1. Cultural methods
 - a. Fertility management
 - b. seeding rates

2. Scouting and monitoring

D. Nematodes

1. Resistant varieties

2. Scouting and monitoring
- a. nematode symptoms
 - b. soil sampling

Foliage

A. Insects

- 1. Biological control
- 2. Resistant varieties
- 3. Scouting and monitoring
- 4. Regulatory control
 - a. inspection
 - b. quarantine

B. Diseases

- 1. Resistant varieties
- 2. Scouting and monitoring
- 3. Regulatory control
 - a. quarantine
 - b. inspection
 - c. rootstock certification

Stored Grains

A. Insects

- 1. Biological control
- 2. Scouting and monitoring
- 3. Regulatory control
 - a. quarantine
 - b. inspection

B. Diseases (mold, etc.)

1. Cultural control
 - a. Ventilation
 - b. drying
2. Regulatory control
 - a. quarantine
 - b. inspection

Livestock

A. Insects

1. Cultural
 - a. waste management
 - b. sanitation
2. Natural and biological control
 - a. predators
 - b. parasites
 - c. pathogens
3. Scouting and monitoring

Poultry

A. Insects

1. Cultural
 - a. waste management
 - b. sanitation
2. Natural and biological control
 - a. predators
 - b. parasites
 - c. pathogens
3. Scouting and monitoring

Forestry

A. Insects

1. Natural and biological control
2. Resistant varieties
3. Scouting and monitoring

4. Regulatory control
 - a. inspection
 - b. quarantine

B. Diseases

1. Resistant varieties
2. Scouting and monitoring
3. Regulatory control
 - a. inspection
 - b. quarantine

C. Weeds

1. Cultural
 - a. row spacing
 - b. cultivation

IPM CHART

	cultural methods (list)	natural and biological control	resistant varieties	scouting and monitoring	regulatory control
<u>Field crops</u>					
- insects					
- diseases					
- weeds					
- nematodes					
<u>Vegetables</u>					
- insects					
- diseases					
- weeds					
- nematodes					
<u>Pastures</u>					
- insects					
- diseases					
- weeds					
- nematodes					
<u>Citrus</u>					
- insects					
- diseases					
- weeds					
- nematodes					

	cultural methods (list)	natural and biological control	resistant varieties	scouting and monitoring	regulatory control
<u>Turf</u>					
- insects					
- diseases					
- weeds					
- nematodes					
<u>Foliage</u>					
- insects					
- diseases					
<u>Stored Grains</u>					
- insects					
- diseases					
<u>Livesotck</u>					
- insects					
<u>Forestry</u>					
- insects					
- diseases					
- weeds					

EVALUATION

3. List three (3) methods of controlling insect pests and write one way that each uses or saves energy.

4. List three (3) methods for control of crop diseases and write one way that each uses or saves energy.

5. List three (3) methods of weed control and write one way that each uses or saves energy.

6. For the following list of types of crops and livestock, write one class of pest affecting each and two (2) control methods that can be integrated to save energy in the management of that pest.

1. field crops
2. vegetables
3. pastures
4. citrus
5. turf

6. foliage
7. stored grains
8. livestock
9. poultry
10. forestry

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